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THE THORACIC SCLERITES AND WING BASES OF THE ROACH *PERIPLANETA AMERICANA* AND THE BASAL STRUCTURES OF THE WINGS OF INSECTS

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The head and abdominal structures of the American roach have been described in Vol. 32, p. 195 of Psyche for 1925. In the present paper the thoracic sclerites and wing bases of the roach are discussed, and certain previously overlooked structures in the basal region of the wings of insects in general are described, since they appear to be of considerable interest from the standpoint of phylogeny and the interpretation of the wing veins

In examining the thoracic sclerites, it is preferable to study them in relation to the internal structures for muscle attachment, etc., and with this purpose in view, the dorsal (or the ventral) region of the thorax should be cut away, and the parts should be boiled in 10% caustic potash to remove the muscles and other soft parts, which may be washed away with a pipette. The parts should be studied immersed under water or alcohol, and the field of the binocular should be illuminated by a brilliant light provided with a bulls-eye condenser.

The neck ("cervicum" or eucervix) is a demarked anterior portion of the prothorax, whose membranous walls permit greater freedom of movement for the head. Its sclerites, called the cervical sclerites (cervicalia) are homologous with the intersegmental plates (intersegmentalia) occurring between the thoracic segments in certain Apterygota, and, according to their position, they are called the dorsal, lateral and ventral cervicals.

The ventral cervicals *pgu* and *is* of Figs. 1 and 5 are narrow, transverse sclerites, homologous with the sclerites called the postgulare and intersternite by Crampton, 1926. The lateral cervicals *lc* of Figs. 1 and 5, are the largest neck plates, and each is made up of three parts, or subdivisions. The anterior subdivision *ec* bears a cephaliger *cg* or process which articulates with the occipital condyles *occ* of the head. The median lateral cervical *ic* touches its fellow of the opposite side in the median ventral line of the body, in the fashion characteristic of most roaches, mantids and termites. The posterior lateral cervical area *poc* is inflexed and bears a small internal protuberance at the point *f* of Fig. 5. The small sclerite *t* of Figs. 1 and 5 may be included with the lateral, or with the dorsal, cervicals. The dorsal cervicals *pr* (Fig. 15) are small and unimportant, but the dorsal cervicals *it* are quite large and unite posteriorly to form a horse-shoe-shaped area bearing a pair of internal protuberances. The posterior dorsal cervicals (or postintertergites) bear the internal tendons *et* (Fig. 15) for muscle attachment.

The sternal region of each thoracic segment (excepting the metathorax) contains three typical sternites or sternal sclerites as follows. The basisternite *bs*1, *bs*2, and *bs*3, of Fig. 1, is the principal sternite and is usually connected with the episternal region *es* by a precoxal bridge *pc*. In the mesothorax and metathorax, the basisternum *bs*2, and *bs*3, of Fig. 1 is composed of an unpaired median portion and two lateral halves.

The furcasternite (or furca-bearing sternite) *fs*1, is subtrapezoidal in the prothorax, but it is shaped like an inverted "Y" in the meso— and metathorax. The furcasternite *fs* (Fig. 1) bears the furcal pits, or furcacavæ *fp*, which are the external manifestations of the invaginations forming the internal diapophyses, or furca *fu*, of Fig. 5. These paired apophyses, or diapophyses (furca), serve to hold the nerve chain in place, and they furnish attachment for muscles etc. Miall and Denny in their book on the cockroach failed to find the prothoracic furca *fu* of Fig. 5, but these structures are quite well developed in the prothorax, and are composed of a delicate shaft, or basifurca, and a broad distal portion, or distifurca, which extends to the apodeme *ap* of the pleural region.

The spinasternite *ss* of Figs. 1 and 5 is not very greatly elongated in the prothoracic region, but in the mesothorax it is long and slender. The spinasternite of the metathorax is atrophied, or it is indistinguishably united with the furcasternite *fs*, in this region. The spinasternite *ss* of Fig. 1, bears the spinal pit, or spinacava *sp*, which is the external manifestation of the invagination forming the internal, median, unpaired apophysis called the monapophysis, or spina *spi*, of Fig. 5, which serves for muscle attachment etc.

The internal sternal processes, such as the furca *fu* and spina *spi*, may be called the endosterna, and as was mentioned above, these endosterna serve tor the attachment of muscles etc. As was suggested by Crampton, 1918, instead of designating muscles by their function etc., it is preferable to designate them by their points of origin and insertion; and if this method be followed, we may speak of the furco-apophysal muscles, the furco-coxal muscles, furco-trochanteral muscles, etc., or the profurco-mesofurcal muscles, prospino-mesospinal muscles, etc., and the terms are self-explanatory.

In the three thoracic segments (Fig. 1), a pre-coxal bridge composed of the sclerites *pc* and *ac* connects the basisternite *bs* with the episternum *es*. The sclerite *pc* is very loosely connected with the pleural region in the meso- and metathorax, and may possibly represent the sclerite called the lateropleurite, while the sclerite *ac* which is well developed and is connected with the sternal region in the mseo- and metathorax, may represent the laterosternite; but provisionally, at least, I have followed- the interpretations indicated by the labelling, (see list of abbreviations) until the matter can be definitely determined.

In the meso- and metathorax, a ventral prolongation of of the suture *s* (Fig. 1) demarks the preepisternum *pes* or anterior marginal sclerite, which bears an internal protuberance for muscle attachment. In front of this region is a "dimple-like" impress, or depression labelled *i* in Fig. 1, which marks the location of an internal tumulus, or protuberance labelled *en* in Fig. 5, to which certain muscles are attached

An infolding (or "inpocketing") of the integument of the pleural region forms an internal ridge, or endopleuron *ep* of Fig.

5, while the external lips of the fold meet to form the pleural suture *ps* of Fig. 1, which demarks the epimeron *em* from the episternum *es*. At the ventral end of the pleural suture *ps* of Fig. 1, is the coxifer *cf*, or coxa-bearing process, while at the dorsal end of the pleural suture *ps* is the alifer *o*, or pleural fulcrum of the wing. Internal processes of the coxifer labelled *ecf* 3 in Fig. 5, and internal processes of the alifer, labelled *ea* 2 in Fig. 5, are fairly well developed in the roach; and the endopleuron *ep* of Fig. 5 gives off an apodeme, or process *ap*, rather closely associated with the furca *fu*.

In the meso- and metathorax, there occurs in front of the pleural suture *ps* of Fig. 1, a suture *r*, which divides the episternal region *es* into an upper region *aes*, or anepisternite, and a lower region, or katepisternite (bearing the label *es* in Fig. 1). An anepisternal incision *aei* divides the anepisternite into an anterior and posterior region. The basalar sclerites *x* and *u*, situated dorso-caudad of the anepisternal incision *aei* (Fig. 1), are portions of the pleural region. The anterior basalare *u* of Fig. 1 is demarked by the suture *s*, and it bears an internal process *eb* of Fig. 5. The posterior basalare *x* of Fig. 1 is a detached portion of the pleural region in front of the alifer *o*, and both of the basalar sclerites are associated with the movements of the wing in flight.

Above the alifer *o* of Fig. 1 is the intraalare *ia* (See also Figs. 13 and 14), which is an alar ossicle connected with the dorsal alar ossicle *a* of Fig. 16 (Compare also Figs. 13 and 14). The sclerite *ia* may be a detached portion of the wing structures, but it is hardly a detached portion of the pleural region. The subalare *sa* of Fig. 1, however, may have been formed by the deposition of chitin in the membrane below the wing, for the attachment of the mero—subalar muscles extending between the meral region of the coxa and the subalar plate in question.

The trochantin, bearing the labels *atn* and *ptn* in Fig. 1, is a triangular plate in front of the coxa, and the trochantin bears at its tip an internal trochantinal tendon *ttn* of Fig. 5, for muscle attachment. A trochantinal suture, with its corresponding internal ridge or endotrochantin *etn* of Fig. 5, divides the trochantin of the meso— and metathorax into an anterior region *atn* and a posterior region *ptn* (Fig. 1), while a transverse "break," or cleft, divides the prothoracic trochantin into a basal region *btn* and a distal region, *dtn*, as is also the case in other roaches, mantids and termites, etc. In such cases, the small distal region *dtn* is usually interpreted as the entire prothoracic trochantin, althrough the basal portion *btn* also belongs to the prothoracic trochantin. The trochantin of all segments is closely associated with the pleural region (from which it is separated by the pleurotrochantinal suture *p* of Figs. 1 and 5) and it may be a detached portion of the pleural plate. On the other hand, it is maintained by several investigators that the trochantin (or even portions of the pleural plate itself) is a detached basal region of the leg, to which the term subcoxa is sometimes applied.

Between the trochantin and the coxa is a small sclerite *pac* called the paracoxale, which bears an internal paracoxal tendon *pat* (Fig. 5) for muscle attachment. The sclerite *pac* is either a detached portion of the marginal region of the coxa, or it was formed in the membrane between the trochantin and coxa, to bear the internal tendon *pat* for muscle attachment. Behind the coxa is an internal tendon *pt* (Fig. 5) called the postcoxal tendon, to which are attached certain muscles. A faint "impress" marks its location externally.

In the prothorax, a marginal region, the basicoxale *bc* of Fig. 1, is demarked in the basal region of the coxa. Its anterior region *cm* has been termed the coximarginale, and its posterior region *me* is homologous with the meron *me* of the other legs. An internal ridge, or endocoxa, demarks the region *bc* internally, and serves for the attachment of muscles, as described by Dr. R. E. Snodgrass. In the meso- and metathorax, the meral region *me*2 and *me*3 is much more extensive than inthe prothorax (i. e. *me* of Fig. 1), and a meral ridge, or endomeron *mr* of Fig. 5, serves to demark the meral region internally—and it also serves as a ridge for muscle attachment. The parts of the leg of a roach, together with their tendons, method of articulation, etc., have been described in a paper by Crampton, 1923 (Can. Ent. LV, p. 126), and need not be further discussed here, since the appendages of the thorax will be described more fully in a paper dealing with the legs and wings of the roach.

The spiracle *st* between the pro- and mesothorax (Figs. 1 and 5) is mesothoracic in origin, and should therefore be spoken of as the meso-thoracic spiracle, despite the fact that it is very closely associated with the prothoracic region. The second spiracle is metathoracic, and the third one is the first abdominal spiracle. The mesothoracic spiracle is usually located in the membranous region continuous with that containing the spinasternite *ss* (Figs. 1 and 5), particularly in larval forms, and this may indicate that the supposed prothoracic spinasternite is mesothoracic rather than prothoracic. In any case, this sternite may be referred to as the spinasternite, although if it belongs to the mesothorax (as its association with the spiracle in other insects seems to indicate) the term poststernellum, applied to it by some investigators, is hardly applicable, since it would then be the anteriormost mesothoracic sternite, instead of the posteriormost prothoracic sternite (as the name "poststernellum" would indicate). The relation of the spiracles to the thoracic sclerites, the mechanism of the thoracic spiracles, and similar topics will be discussed in a paper dealing with the respiratory system of the roach, and need not be further discussed here.

As is shown in Fig. 12, the pronotal plate or "pronotum" is divided into a disk or central portion labelled *disc* and a marginal region or limb labelled *limb*, whose lateral areas are called paranota. The ventral inflexed margins of the pronotum are closely applied to the dorsal surface of the pronotum (above) and the edges of these margins apparently exert a tension, resulting in the formation of faint lines such as those indicated by the dotted lines bordering the disk of the pronotum shown in Fig. 12. In the discal region, labelled *disc*, are several muscle-scars, or myocicatrices, etc., which need not be further discussed at this time, since they will be described in a paper dealing with the muscular system of the roach. The pronotal plate probably corresponds to the eunotum (or wing bearing plate) of the other thoracic segments, in which a prescutum, scutum and scutellum are secondarily demarked in the eunotum of the meso— and metathorax, but these areas are not demarked in the pronotum. The poorly chitinized and pigmented area labelled *psl*1 in Fig. 16, probably represents the postscutellum of the other thoracic segments (in which the postscutellum is formed behind the eunotum or wing-bearing plate). The small anterior margin of the mesonotum bearing the label *pm* in Fig. 16 may be considered as a posterior portion of the prothorax, since, as Dr. Snodgrass points out, the phragmas represent the lines of demarcation between the segments dorsally, and the area *pm* of the mesonotum (Fig. 16) lies in front of the phragmas (or internal structures for muscle attachment, whose location is indicated by the pits *ppt* of Fig. 16) and should therefore be reckoned to the prothoracic region, although it is borne on the anterior margin of the mesonotum.

In the meso- and metanotal region, the wing bearing plate, or eunotum, is divided into the following regions. The anteriormost sclerite, or pretergite,*prt* of Fig. 16, is an ill-defined region bearing the phragmal pitts *ppt* which mark the location of the internal ridges or phragmas *ph* of Fig. 13, for example, and these phragmas or phragmal ridges delimit the segments dorsally, so that the anterior marginal region *pm* of the pretergite being anterior to the phragmas, belongs to the segment in front, as was mentioned above. In the mesonotum of the roach (Fig. 16) the prealar sclerite *pra* becomes detached from the lateral region of the pretergite *prt*, while in the mesonotum of the mantid shown in Fig. 6, the region *pra* forms an incomplete prealar bridge, which is well developed in such insects as the Plecoptera, etc. In the metanotum of the roach (Fig. 16) the prealar sclerite *pra* does not become detached (as it does in the mesonotum) but it bears a pit like that labelled *pp* in the prealar sclerite *pra* of the mesonotum. The anterior margins of the sclerites *prt* and *pra* apparently become involved in the formation of the postscutellum of the segment in front, when the postscutellum is enlarged through further chitinization and pigmentation of the "intersegmental" membrane to form the large postscutellar plate of other insects

The faintly demarked median region labelled *psc* in the mesonotum of the roach (Fig. 16) corresponds to the prescutum of the mantid shown in Fig. 6, and represents the second important area demarked in the eunotum (or wing-bearing plate). The regions labelled *pn*2 and *pn*3 in the meso- and metanotum of the roach (Fig. 16) are probably secondarily-formed areas demarked by a rather faint suture *pns*, with its corresponding internal ridge *epn*2 of Fig. 13. These structures are extremely faint in the metanotum (Fig. 16).

The scutellum of the mesothorax *sl*2 is greatly elongated and extends to the prescutal area *psc* of Fig. 16. In the metathorax, however, the scutellum *sl*3 is shorter and a suture-like structure *mds* of Fig. 16 connects it with the prescutal region. The scutellum *sl*2 (Fig. 16) is a demarked area of the eunotum bounded laterally by the scutellar sutures *sls* with their corresponding internl ridges etc., labelled *esl*2 in Fig. 13

Behind the scutellum *sl*2 (Fig. 16) is the posttergite *pot*, which is formed by a posterior fold, or reduplication, of the wing-bearing plate, or eunotum. Behind this are the postscutellar plates *psl* (Fig. 16), which encroach upon the membranous region, in other insects, and finally incorporate the marginal region *pm*, in front of the phragmal pits *ppt*, to form the large postscutellum of higher insects, in which the postscutellum may appear to bear the phragma. The postscutellum of the roach is but feebly developed and is represented by the small plates bearing the label *psl* in Fig. 16. These plates are formed behind the wing-bearing plate, or eunotum, whose post. erior margin is continuous with the posterior margin of the wing.

In the eunotum, or wing-bearing plate, the scutum *sc* (Fig. 16) is very large and it occupies the greater part of the eunotum. It bears an anterior wing process, or suralare *sur* (which may be a lateral portion of the region *prt* in some insects), and a posterior wing process, or adanale *ad* (Figs. 16, 6 and 10), in front of which is an important incision *ni*, serving to divide the scutum into an anterior region and a posterior region, the latter being practically equivalent to the region called the parascutellum in other insects. The incomplete sutures extending mesad from the incision *ni* in Fig. 16, correspond in a general way to the transscutal sutures, dividing the scutum into an anterior and posterior region in certain insects.

A tegular incision *ti* of Fig. 6, usually separates the prealar sclerite *pra* from the suralar sclerite *sur*, and the tegula *tg* is located at the mouth of the incision in most insects (Figs. 6, 10, 13, 16, etc.). The tegula *tg* (Figs. 6 and 16) is probably formed by the deposition of chitin and pigment in the membrane near the tegular incision *ti*, but the parategula, or basicostale *ptg*2 (Figs. 6 and 16), is probably a detached basal portion of the costal region (or vein) of the wing.

Behind the suralar sclerite *sur* of Figs. 6, 10, 16 etc., is the suralar incision *si* and the alar ossicle labelled *n* in these figures, which is called the notale, or notopterale, is located in the neighborhood of the incision *si*. The alar ossicle *n* appears to be a detached portion of the notum. It is prolonged anteriorly into a neck-like, slender portion, whose "head" abuts against the end of the sclerite *scc*. The sclerite *scc* is a demarked "head" of the subcostal vein, and is the dorsal portion of the subcostale *d* (Figs. 1, 13, etc.) located on the under surface of the wing.

The medialia, or median ossicles *a*, *b* and *c* of Figs. 6, 10, 16 etc., intervene between the ossicle *n*, and the base of the wing-veins radius and media. The proximal mediale *a*, is separated from the ossicle *n* by the cleft *nm* of Fig. 16, and ossicle *a* sends down a ventral prolongation *ia* of Fig. 14, to form the ossicles labelled *ia* in Fig. 1, which are located just above the alifer *o* (the wing-bearing process of the pleuron). The incision *in* of Figs. 6 and 16 separates the ossicle *a* from ossicle *b*, which is usually, closely associated with the ossicle *ba* of Figs. 6, 10 and 16. The suture (or cleft) *im* of Figs. 6, 10 and 16, separates the intermediate median ossicle *b* from the distal median ossicle *c*. Ossicle *c*, in turn, is separated from the head of the vein labelled *mca*, by the suture labelled *ms* in Figs. 16, 6 and 10.

The basanal ossicle *ba* of Figs. 16, 6, 10 etc., usually articulates with the posterior notal wing process, or adanale *ad*, at one end, while at the other end, it is associated with the ossicle *a*, and is usually united more or less closely with ossicle *b* (see also Fig. 14). The anale, or anal ossicle *an* of Figs. 6, 10 and 16, intervenes between ossicle *ba* and the base of the anal region in the fore wing of the roach, mantid and termite here figured. Faint traces of a postbasanal ossicle may be seen behind the ossicle labelled *ba*, in the metanotum of the roach shown in Fig. 16.

In the fore wing of the roach shown in Fig. 16, the mantid shown in Fig. 8, and the termite shown in Fig. 10, the anal, or claval, area *aa* of the tegmen (fore wing) is connected with the notum by a region called the alula, or jugalula *ja* which may be involved in the formation of the jugum etc., of higher insects. An axillary ridge, or a crack-like rima *po* (Figs. 6 to 10), separates this region from the anal or claval region *aa* (Figs. 6, 7, 8, 9, 10, 16 etc. and the veins which are located behind this line of demarcation (i .e. such as those labelled *ax* in Figs. 8, 9, etc.) should be referred to as the axillaries or axillary veins. The faintly chitinized and pigmented areas labelled *ju* in Figs. 6, 10 and 16, are formed in the basal region of the alula; and the sclerite behind the metathoracic ossicle *ba* of Fig. 16, may be associated with these areas of the fore wings. The sclerite *pju* of the hind wing of the roach (Fig. 16), however, seems to be formed behind the area containing the region *ju* in the fore wing (Fig. 16), and is connected with a different portion of the notum by a narrow neck as is shown in Fig. 16. The relation of these parts to the calypteres of Diptera, etc., will be discussed in another paper.

In studying the fore wing of the roach I noticed a basal, ridge-like fold *bp* and a deep "marsupium" or basal sinus *bsi* (best seen after boiling the parts in caustic potash to spread them apart more readily), such as that shown in the tegmen (modified fore wing) figured in Fig. 16 These structions are very prominent, but have been apparently overlooked before, although they occur in a great many of the insects descended from the ancestral types included in the common Protorthopteron-Protoblattid stem—e. g. in such insects as those shown in Figs. 11, 16, 7, 8, 9, and 10. I do not find this basal fold and sinus in such insects as the ephemerids and Odonata which cannot lay their wings back along the top of the abdomen in repose, while the descendants of the groups which can do this (see division of insects into two groups on this basis in Vol. 16 p. 33 of the Journal of Ent. and Zoology for 1924, or papers in the Transactions of the Amer. Ent. Society,,LII, 1926,p. 239) show distinct traces of the fold and sinus (as I have also pointed out in the Bull. Brooklyn Ent. Soc., 1927, XXII, p. 1) so that the presence of these structures is of considerable importance from the standpoint of phylogeny, and these structures likewise serve as landmarks in determining the location of certain veins, areas etc., of the wing. The basal fold *bp* and pocket-like sinus *bsi* are very prominent in the fore wings of roaches, termites, the Hemiptera with coriaceous fore wings, etc., and it is very probable that these structures were developed in order to facilitate the folding back of the fore wings, when these are laid along the top of the abdomen in repose (see Bull. Brooklyn Ent. Soc., 1927). I shall again refer to these structures in a paper dealing with the basal region of the wings of insects in general, so that it is not necessary to discuss the matter further at this time.

As was mentioned above, a postanal, or postclaval ridge (or in some cases a rima, or crack-like line) labelled *po* in Figs. 6, 7, 8, 9, 10 and 16, demarks the axillary, or alular region, from the anal, or claval region of the fore wings. A preanal, or preclaval rima *cl* demarks the anal area of the wing from the median region of the wing, and the rima *cl* may be regarded as a "rima dividens" paralleling the "vena dividens" described by Comstock and others, in this region of the wing. A median rima, in front of the rima labelled *cl* in Figs. 10 and 16, demarks the median area of the wing from the radial area, in some insects, and a costal area *ca* of Fig. 16, is frequently demarked by the subcostal vein *Sc* in roaches, termites etc.

On the under side of the fore wing of the roach, as shown in Fig. 2, there is an important ventral ridge, the subcostal crista or plica *scr*, extending along the subcostal vein, and the condition exhibited in this region of the fore wing of the roach is of considerable interest from the standpoint of phylogeny, since the tegmen (fore wing) of the roach offers a very suitable startingpoint for tracing the modifications in this area of the elytra of beetles and the fore wings of other insects descended from roach-like forebears in the common Protorthopteran-Protoblattid stem.

When the fore wing of the roach is laid back in repose, it assumes the position shown in Fig. 2; and a protuberance *m* of the epimeron *em* 2 fits into a cavity in which the sclerite *d* at the base of the subcostal vein (or subcostal ridge *scr*) is located. The subcostal ridge *scr* lies above, and mesal to, the projecting areas of the epimeron *em*2 and meron *me*2 in repose, and the subcostal ridge may have been developed in connection with holding the wing in place when at rest. When the hind wings are folded back in repose, the sclerite *x* of Fig. 4, projects into a pocket between the structures labelled *ptg* 3 and *d* in Fig. 4, and the costal edge of the hind wing lies above the process *m* of the epimeron *em* 3. Much of the anterior region of the wing lies on top of the area labelled *w* in Fig. 3, and this area was apparently developed in connection with holding the wing up in repose.

A more detailed description of the folding of the wings, the basal structures of the wings, the areas of the wings, the interpretation of the veins (indicated in Fig. 16), and the mechanism of flight, etc., will be given in a paper dealing with the thoracic appendages of the roach, and need not be further discussed here.

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ABBREVIATIONS

a	Proximal median ossicle (proximediale)
aa	Analarea or clavalarea
ac	Antecoxale (laterosternite?.)
ad	Adanal process (adanale)
aei	Anepisternal incision
aes	Anepisternum
an	Anal ossicle (anale)
ap	Apodeme of endopleuron
atn	Antetrochantin
ax	Axillary vein
b	Intermediate median ossicle (intermediale)
ba	Basanal ossicle (basanale)
bc	Basicoxale or basicoxa
bi	Subcostal incision or sinus
bp	Basoplica or basocrista
bs	Basisternite or basisternum
bsi	Basosinus
btn	Basitrochantin
c	Distal median ossicle (distimediale)
ca	Costalarea (embolium)
cf	Coxafer
cg	Cephaliger
cl	Rima dividens (preclavorima)
cm	Coximarginale
Cu	Cubital vein
cx	Coxa
d	Subcostal sclerite (subcostale)
disc	Disk of pronotum
dtn	Distitrochantin
e	Endoprealare
ea	Endoalifer
eb	Endobasalare
ec	Anterior lateral cervical plate (eucervicale)
ecf	Endocoxifer
ecx	Anterior coxal region (eucoxa)
em	Epimeron
en	Tumulus of endopapilla
ep	Endopleuron
epn	Endoprenotum
es	Episternum
esa	Endosuralare
esl	Endoscutellum
et	Tergal tendon (endotergite)
etn	Endotrochantin
f	Point on precoxa for muscle attachment
fp	Furcal pits (furcacavae)
fs	Furcasternite or furcasternum
fu	Diapophyses or furca
g	Antecoxal suture
i	Prepectal impress
ia	Intraalar ossicle (intralare)
ic	Intermediate cervical plate (intercervicale)
it	Intertergite
im	Intermediate surure or incision
in	Submedian suture or incision
is	Intersternite
ja	Alula (jugalula)
ju	Jugale
lc	Laterocervicale
limb	Limb of pronotum
M	Media or median vein
m	Epimeral process
ma	Interarea of wing
mc	Medicervicale
mca	Head of Media (mediacaput)
me	Meron
mds	Middorsal suture
mr	Meral ridge (endomeron)
ms	Median suture or cleft
n	Notale
ni	Scutal incision
nm	Notomedian suture
o	Alifer
occ	Occipital condyle
p	Trochantino-pleural suture
pac	Paracoxale
pat	Paracoxal tendon
pc	**Precoxale**
pes	Preepisternum
pgu	Postgulare
ph	Phragmal ridge and process
pju	Postjugale
pm	Notomarginale
pn	Prenotum
pns	Prenotal suture
po	Posterior rima (postrima) or ridge
poc	Postcervicale
pot	Postergite
pp	Prealar pit
ppt	Phragmal pit (phragmacava)
pr	Precervicale
pra	Prealare
prt	Pretergite
ps	Pleural suture
psc	Prescutum
psl	Postscutellum
pt	Postcoxal tendon
ptg	Parategula or basicosta
ptn	Posttrochantin
R	Radial vein
r	Anepisternal suture

s.......Preepisternal suture
sa......Subalare
san.....Subanale
sb......Subcostale
Sc.....Subcostal vein
sc......Scutum
scc.....Subcostal head (subcostacaput)
scr.....Subcostal crista (subcrista)
si......Suralar incision
sl......Scutellum
sls.....Scutellar suture
sp......Spinal pit (spinacava)
spi.....Spina or monapophysis

ss......Spinasternite
st......Spiracle
su......Subspiraculare
sur.....Suralare
t.......Prepleurite
tg......Tegula
ti......Tegular incision
tn......Trochantin
ttn.....Trochantinal tendon
u......Anterior basalare
v......Subcostal incision
w......Wing imprint on epimeron
x......Posterior basalare

Explanation of Plates I, II, III.

Fig. 1. Ventral view of sternal and pleural region of the thorax of the roach, spread out as though lying in one plane.
Fig. 2. Ventral view of the mesothoracic wing-base, pleural region and meral region of the leg of the roach.
Fig. 3. Ventral view of basal region of the metathoracic wing folded back in repose.
Fig. 4. Ventral view of metapleural region and base of hind wing spread out slightly.
Fig. 5. Internal processes of the sternal and pleural region of the thorax of the roach seen from above (i. e. from within).
Fig. 6. Lateral portion of the mesonotum and the base of the fore wing (extended) of the mantid Mantoides.
Fig. 7. Postero-basal region of the hemielytron of a Pentatomid.
Fig. 8. Postero-basal region of the fore wing of Panorpa (seen from above).
Fig. 9. Postero-basal region of fore wing of the sawfly Pteronidia.
Fig. 10. Basal region of the fore wing of the termite Mastotermes.
Fig. 11. Basal region of the fore wing of the beetle Calopteron.
Fig. 12. Pronotal plate of the roach (dorsal view)
Fig. 13. Mesonotum of the roach seen from within.
Fig. 14. Lateral portion of metanotum and wing base of the roach seen from within.
Fig. 15. Mid-dorsal region of the neck of the roach seen from within.
Fig. 16. Dorsal view of meso- and metanotum, with basal regions of the wings of the roach.

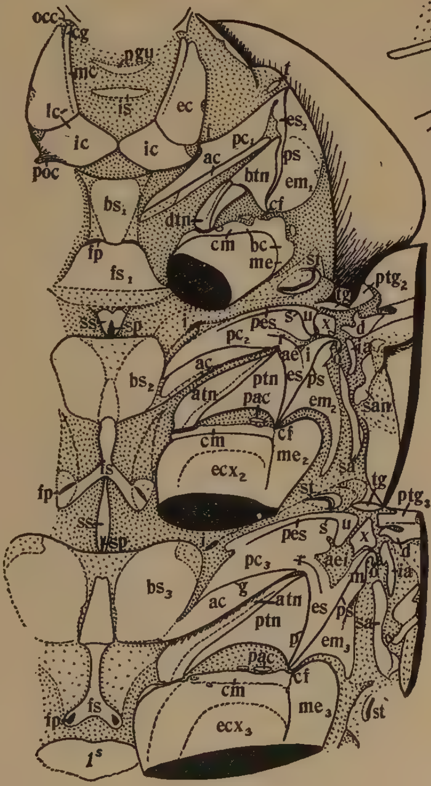


Fig. 1

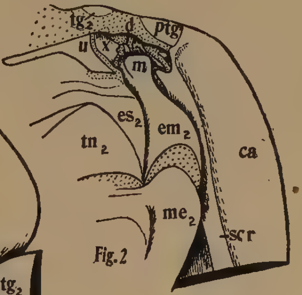


Fig. 2

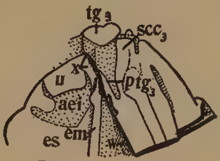
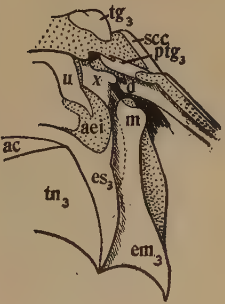


Fig. 3



CRAMPTON—PERIPLANETA AMERICANA.

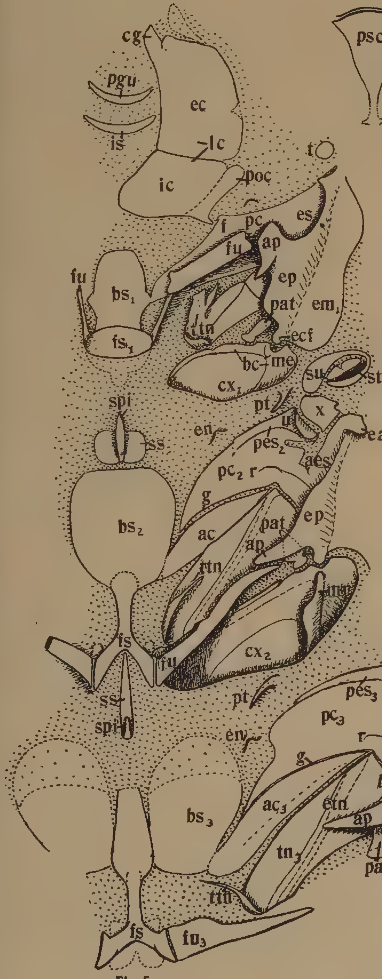


Fig. 5

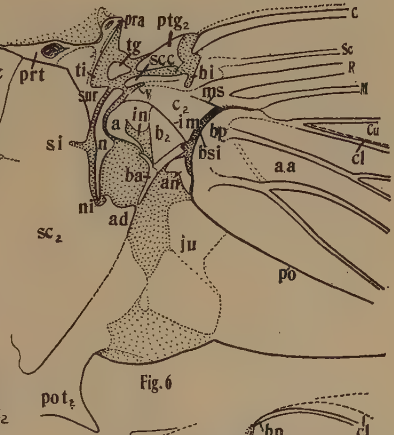


Fig. 6

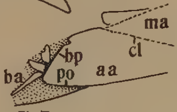


Fig. 7

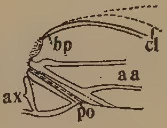


Fig. 8

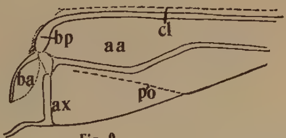


Fig. 9

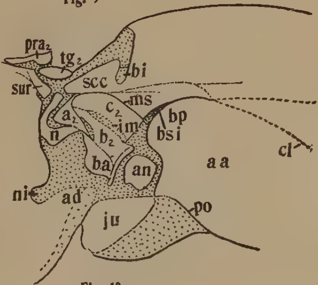


Fig. 10

CRAMPTON—PERIPLANETA AMERICANA.

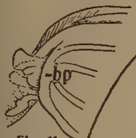


Fig. 11

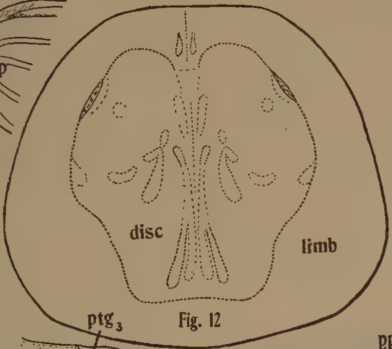


Fig. 12

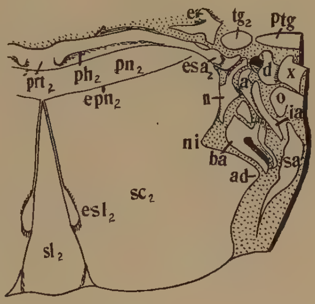


Fig. 13

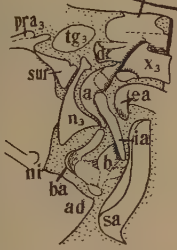


Fig. 14

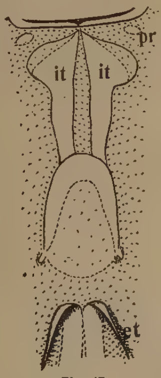


Fig. 15

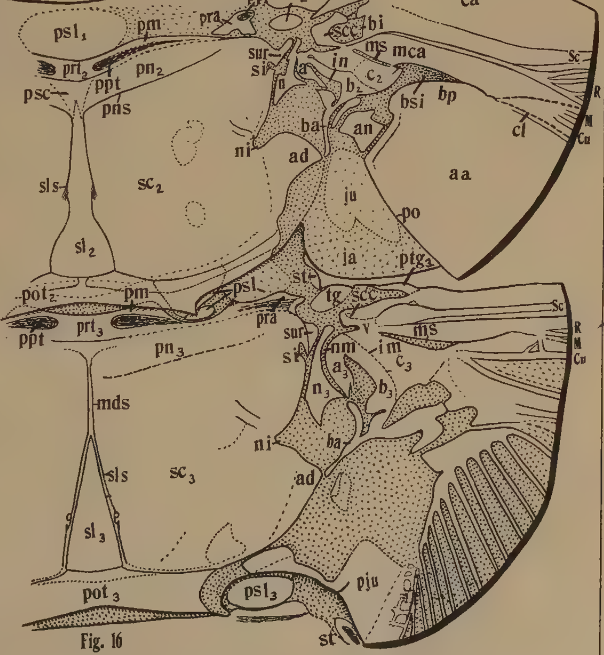


Fig. 16

CRAMPTON—PERIPLANETA AMERICANA.

OBSERVATIONS ON WOOD-BORING INSECTS, THEIR PARASITES AND OTHER ASSOCIATED INSECTS.[1]

BY CHARLES T. BRUES

During the course of many years' interest in the several groups of Parasitic Hymenoptera the writer has frequently been struck by the preponderance of primitive types which prey upon wood-boring insects. Not only this, but several of the most primitive families of phytophagous Hymenoptera develop mainly within the tissues of woody plants and an exceptionally large proportion of the leaf-feeding sawflies subsist upon the foliage of trees. These facts suggest that the early phylogenetic history of the Hymenoptera was in some way bound up in the deveopment of the woody flora and that this early association has persisted to the present time without sufficient change to destroy the earmarks of past history in the modern hymenopterous fauna.

The immediate occasion for the present discussion is a small, but quite varied collection of insects made during the past summer at my summer home in Petersham, Mass. Early in the season the attention of my wife was attracted by a considerable number of flying insects that had congregated upon the panes of a window in a room where the stove wood for the household is stored. This room contains an assortment of wood of various sizes and varieties, principally oak, chestnut, white pine, red maple and birch. The wood is cut in the nearby woodlot one year, allowed to season and then sawed, split and stored away the next year. Before storage, it has therefore an opportunity to be attacked by various wood boring insects and fungi together with the insects that are attracted to the latter.

So many specimens appeared on the first day that collections were made daily upon the window from early July to late September and by the end of the season we had amassed a considerable collection. After sorting and identification, the following list was compiled which includes practically all of the species taken.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 275.)

COLEOPTERA

Nearly all of the members of this order have been identified by one of my students, Mr. P. J. Darlington, Jr.

Family Rhipiphoridæ

Pelecotoma flavipes Melsh. Twenty-one specmens of both sexes of this rare species, July 13-28. This has been reported emerging from beech wood, but the present specimens came from that of some other tree, probably red maple. The habits of the larvæ appear to be unknown, although the genus is undoubtedly parasitic.

Family Pyrochroidæ

Dendroides bicolor Newm. Three males July 13 and 18. This species breeds commonly in various deciduous trees such as oak, maple, beech and birch

Dendroides concolor Newm. One female July 13. This species is known to feed upon the same trees as the foregoing.

Family Elateridæ

Melanotus trapezoideus Lec. One specimen, July 20.

Melanotus pertinax Say. One specimen, July 13. Members of this genus are commonly taken beneath the bark of various trees.

Family Melasidæ (Eucnemidæ)

Isorhipis ruficornis Say. 245 specimens representing both sexes in the proportion of 127 males to 118 females. This species was the most abundant insect in the present collection. It was taken first on July 13 and was still appearing when the last collections were made late in September although present in greatest numbers late in July. The species has been found in beech and soft maple and most if not all of the present series emerged from red maple.

Family Buprestidæ

Dicerca lurida Fabr. One specimen, July 13. This species breeds commonly in hickory, although the present one came probably from an oak log.

Chrysobothris femorata Oliv. One specimen, July 13. This is a common enemy of apple, but the larvæ occur in several other deciduous trees.

Family Dascyllidæ

Eucinetus morio Lec. One specimen, July 20. This has been taken beneath oak-bark and on fungi on oak.

Family Dermestidæ

Attagenus piceus Oliv. Two specimens, July 26-28. This is the well known "carpet beetle" which develops in woolen materials, feathers and other articles of animal origin. Weiss and West (Proc. Biol. Soc. Washington, vol. 33, p. 6 1920) record it from a fungus *Lenzites betulinus* so that its occurrence in the present series is probably not accidental. In country houses the larvæ find food in the many flies and other insects that enter the walls, window casings, etc. for hibernation, many of them to die before the advent of spring.

Family Ostomatidæ (Trogositidæ)

Thymalus marginicollis Chev. Two specimens, July 20. This species breeds in the common shelf-fungus of birch, *Polyporus betulinus.*

Family Nitidulidæ

Epuræa sp. One specimen. The members of this genus feed on fungi.

Family Mycetophagidæ

Mycetophagus flexuosus Say. One specimen, August 23. A common fungus-beetle.

Family Endomychidae

Endomychus biguttatus Say. One specimen, August 23. This is another fungus-beetle.

Family Tenebrionidæ

Diaperis maculata Oliv. One specimen of this abundant species which occurs in fungi, especially in the shelf-fungus of birch.

Upis ceramboides Linn. One specimen, August 8. This is a northern beetle with circumpolar distribution; it occurs under the bark of logs of various kinds.

Family Melandryidæ

Synchroa punctata Newm. Six specimens, July 13 to 20. This species occurs under the bark of various trees, particularly pine and maple.

Family Anobiidæ

Hadrobregmus carinatus Say. Eleven specimens, July 13-17. This species breeds commonly in maple logs and more rarely in those of other trees, such as beech.

Ptilinus ruficornis Say. 18 specimens, July 13-20. This small beetle has been bred from dead branches and logs of various deciduous trees.

Family Cerambycidæ.

Thirteen species of this large family were collected. Practically without exception all members of the group are wood-borers.

Hypermallus villosus Fabr. One specimen, July 19. This is the common "twig-pruner" of oak which occurs occasionally in maple also.

Brachyleptura rubrica Say. One specimen, July 20. The host tree of this tree has apparently never been recorded. It probably occurs in oak.

Brachyleptura canadensis Fabr. One specimen, August 8. The larva develops in the wood of several conifers.

Phymatodes testaceus Linn. One specimen, July 13. The larvæ occur in oak and are commonly bred from cord-wood.

Xylotrechus colonus Fabr. Seven specimens, July 13 to September 26. This is a common species, usually bred from oak but found less abundantly in logs of other deciduous trees.

Xylotrechus undulatus fuscus Kirby. One specimen, August 18. This occurs in the wood of conifers.

Neoclytus acuminatus Fabr. Eight specimens, July 17 to September 26. This is an abundant species which develops in a great variety of deciduous trees.

Anthoboscus ruricola Oliv. Five specimens, July 13-18. This is known to feed in hickory and elm; these specimens may have come from the latter.

Monochamus scutellatus Say. One specimen, July 19. This is an abundant species in New England feeding in white pine logs which are soon ruined if allowed to remain unsawed during the warmer part of the year.

Microgoes oculatus Lec. One specimen, July 19. The larva bores in oak and hickory.

Lepturges querci Fitch. One specimen, July 20. This small form develops in the wood of oak, hickory and other trees.

Hyperplatys maculata Hald. Three specimens, July 14 to 20. The larvæ develop in oak and the wood of other deciduous trees.

Urugraphis fasciata. Two specimens, July 19. The larvæ of this species feed commonly in the bark of oak, but occur also in that of other deciduous trees and even in pine.

Family Platystomatidæ

Euparius marmoreus Oliv. Two specimens, August 23 and September 26. This is a fungus-beetle.

Choragus zimmermanni Lec. One specimen, July 28. This is a wood-boring species that has been bred from sweet-gum, but which must have other hosts.

CORRODENTIA

Family Psocidæ

The four species listed below were examined and named for me by Mr. Nathan Banks.

Psocus leidyi Aaron, two specimens.

Psocus variabilis Aaron, two specimens.

Myopsocus sparsus Hagen, seven specimens.

Peripsocus permadidus Walsh, one specimen.

The members of this interesting group are said to feed mainly upon lichens and fungi and many species are consequently associated with trees and old wood.

THYSANOPTERA

Two species were taken which have been very kindly identified by Dr. J. D. Hood.

Family Phlæothripidæ

Hoplothrips karnyi major Hood, two females, July 20 and 26.

Trichothrips sp. One male, July 20. This is probably an undescribed species known to Dr. Hood from Illinois also.

HYMENOPTERA

Family Xiphydriidæ

Xiphydria maculata Say. 147 specimens of both sexes, July 13 to September 26. The great majority of the specimens emerged during the third week in July. The females are extremely variable in size ranging from 8 to 20 mm. in length while the males range from 7-12 mm. This species is known to breed in maple and most if not all the individuals in the present series emerged from red maple logs.

Species of Xiphydria are commonly parasitized by members of the Aulacid genus Pammegischia of which two species were obtained as noted on another page, without question from this wood-wasp.

Family Aulacidæ

Pammegischia pallipes Cresson. Four females and a male, July 13 and 17. The abdomen of two females is black, except the first and second segments; and the others agree with the description given by Bradley ('08) of *P. xiphydriæ* Ashm. The male taken with them is typical of *P. pallipes* and Bradley is undoubtedly right in regarding these two as sexes of the same species. *P. xiphydriæ* has been bred from *Xiphydria provancheri* living in birch twigs according to Viereck and Champlain reared *P. burquei* Prov. from another species of Xiphydria.

Pristaulacus stigmaterus Say. Two females and one male, July 13 and 16.

Gasteruption tarsatorium Say. Two females, July 13 and 17.

Gasteruption incertum Cresson. Two females and two males, July 13 and 17.

Family Braconidæ

Spathius simillimus Ashmead. One female, July 17. This species has been bred from the small Buprestid beetle, *Agrilus bilineatus*, a well known enemy of chestnut and oak. The members of the genus are parasites of small wood-boring beetles, principally bark-beetles of the family Ipidæ.

Helcon ligator Say. Three females and one male, July 13 and 19. This has been bred from several Cerambycidæ, including *Neoclytus acuminatus* Fabr. which is abundant in the present collection.

Blacus longicaudis Prov. Five specimens of both sexes, July 18—September 5.

Ascogaster carpocapsæ Viereck. One male, July 13.

This species, described by Viereck as a Chelonus was bred from the codling moth *Cydia* (*Carpocapsa*) *pomonella* and has since been reared by Wilcox (Psyche, vol. 25, p. 17, 1918) from the Oriental moth (*Cnidocampa flavescens*).

Apanteles consimilis Viereck. Seventeen females and two males, July 14-Aug. 23. According to Muesebeck this is not a common species, or at least has been only rarely taken.

Family Ichneumonidæ

Rhyssa canadensis Provancher. Three females, September 27. As members of this genus are known to parasitize Xiphydria, these probably came from the abundant *X. maculata.*

Arotes amœnus Cresson. Two females, July 13. Species of Arotes are parasites of cerambycid beetles.

Lissonota insita Cresson. Nine specimens of both sexes, July 13—August 22.

Polysphincta texana Cresson. This is a widely distributed parasite of spiders that has been bred by Cushman from the common *Steatoda borealis.*

Family Vanhorniidæ

Vanhornia eucnemidarum Crawford. Thirteen females and seven males, July 13—September 26, all but one taken during July.

This most remarkable insect was made the type of a new family by Crawford in 1909 when he first described it. The types were bred by Van Horn from larval cells of an unidentified Melasid (Eucnemid) beetle and the species has since been recorded by Champlain (Psyche, vol. 29, p. 100, 1923) as a parasite of *Isorhipis flavicornis.* The present series are undoubtedly from the same host, which is abundantly represented in the collection at hand.

Crawford makes no reference to the systematic relationships of Vanhornia except to note that the wing-venation resembles that of Helorus. On account of its exodont mandibles one would naturally compare it with the family Alysidæ and the somewhat dubious insect, Lysiognatha, placed by Ashmead as an Alysiid. It is very evident, however, from the other characters that Vanhornia has no affinities with any Alysiid. The antennæ are not multiarticulate and the wing is provided with a costal cell, both of which are fundamental differences. Also the structure of the abdomen which is heavily chitinized below, and forms a carapace above is entirely dissimilar to that of any Alysiid although in one genus, Symphya of the latter family the tergites are fused. This similarity is however purely superficial. Considering the wide divergence between the two groups we must conclude that the reversed mandibles are of independent origin and that this peculiarity has developed more than once in the order Hymenoptera.

The similarity in venation between Vanhornia and Helorus is very great and in fact there is no difference except that Helorus has lost the upper section of the basal vein which is still present though weak in Vanhornia. Ashmead speaks of the basal vein as bent down to form a discoidal cell in Helorus but this vein is a combination of the lower section of the basal and the first section of the cubitus which form together an arc as is readily seen by comparison with Vanhornia or Ropronia. Ropronia was placed by Ashmead as a part of the family Heloridæ and I think correctly so although Bradley has disputed this. Ropronia again agrees closely with both Helorus and Vanhornia in venation. Aside from the peculiarities of the head associated with the greatly enlarged mandibles, the complete reduction of the abdominal petiole and the greatly developed ovipositor, Vanhornia is clearly similar to Helorus and the Jurassic genus Mesohelorus and the two families must be placed near together in the group Serphoidea. Handlirsch following Viereck has placed Vanhornia next to the Alysiidæ and the strange genus Gnathobracon. This position appears to be clearly untenable as noted above.

Family Chrysididæ

Chrysis verticalis Patton. One female, September 26.

Omalus iridescens Norton. Four specimens, July 17-26. Species of Omalus are parasitic upon wasps that nest in wood *O. corruscans* has been bred from *Stigmus americanus* which is probably the host of the present specimens.

Family Eumenidæ

Odynerus cristatus Saussure. Nine specimens, July 18-28. This is a common species nesting in burrows in wood.

Family Crabronidæ

Solenius (*Crabro*) *interruptus* Lepeletier. One specimen, July 17. Nests in wood.

Blepharipus nigricornis Provancher. Five specimens, doubtfully of this species, July 17-September 26. This nests in wood also.

Family Trypoxylonidæ

Trypoxylon frigidum Smith. One specimen, July 18. Nests in wood.

Family Pemphredonidæ

Pemphredon tenax Fox. Two specimens, probably this species, July 26.

Pemphredon angularis Fox. One specimen, September 26.

Stigmus americanus Packard. Two specimens, September 26.

Passalæcus annulatus Say. Four specimens, July 20-26. This and the preceding three species all build their nests in wood.

Family Hylæidæ

Hylæus (*Prosopis*) *modestus* Say. Two specimens, July 18-August 8.

Family Megachilidæ

Megachile relativa Cresson. One specimen July 17. This and the preceding bee nest in wood.

DIPTERA

Sixteen species were collected, distributed in a number of families. My friend, Professor A. L. Melander, has been so good as to identify all of these except the Phoridæ.

Family Itonididæ

One specimen, July 16. Not in good enough condition for more accurate determination, but probably a xylophagous form.

Family Mycetophilidæ

Sciara sp. One specimen, July 17. Some species of this genus are mycetophagous, developing in fleshy fungi.

Family Chironomidæ

Culicoides sp. One specimen, July 16. Accidental; this is a phlebotomic type with aquatic larva.

Family Scatopsidæ

Reichertella femoralis Meigen. One specimen, July 17.

Family Scenopinidæ

Scenopinus fenestralis Linne. Three specimens, July 20-28, September 26. This is the common "window-fly" frequently seen in houses. The larva is carnivorous and has been reared from the preparatory stages of the clothes-moth.

Family Phoridæ

Aphiochæta pulicaria Fallen. Eight specimens of both sexes, July 14-August 23.

Aphiochæta agarici Lintner. One female, July 17. The larvæ live in various fleshy fungi.

Aphiochæta sp. One female, July 28. This is probably an undescribed species with swollen, heavily chitinized proboscis.

Aphiochæta sp. Eight specimens, July 18-August 23. Similar to *A. iroquoiana* Malloch, but probably an undescribed species.

Family Muscidæ

Muscina stabulans Linn. Two specimens, August 8. The larvæ of this fly are predatory upon other dipterous larvæ.

Family Trypetidæ

Pseudotephritis vau Say. Two specimens, July 23 and August 23. The larvæ occur beneath bark.

Family Oscinidæ

Oscinis nitidissima Meigen. One specimen, July 17. The larvæ of Oscinis develop in the stalks and roots of various plants, particularly grasses.

Family Drosophilidæ

Drosophila quinaria Loew. Two specimens, July 20 and August 22. The larvæ have been found in fruit, but the species may also develop in fungi.

Drospohila affinis Sturtevant. One specimen, July 26. Sturtevant has bred this species from fruit and has found the adults attracted to exuding sap.

Drosophila sp. One specimen, July 26.

HEMIPTERA

Family Miridæ

The two species were kindy identified by Professor H. H. Knight.

Plagiognathus politus Uhler. One specimen, July 18. This leaf-bug feeds on various plants, including apple foliage.

Pilophorus uhleri Knight. One specimen, July 28.

Family Anthocoridæ

Xylocoris cursitans Fall. One specimen, kindly identified by Professor H. M. Parshley.

Family Reduviidæ

Reduvius personatus Linn. One specimen, July 14. This is a predatory species, often found beneath loose bark where it feeds upon other insects.

HOMOPTERA

Family Aphididæ

Melanoxantherium medium Baker. A few specimens of aphids were seen and one taken on July 16th proves to belong to this species which occurs on poplar.

CONCLUSIONS.

The size of the present collection is of course very small but it allows one to draw several conclusions relating to the composition of the insect fauna that is associated with the wood of dead trees; conclusions, it may be added, which are substantiated and supplemented in detail by the vast array of accumulated literature relating to forest insects.

a) In the first place, there are many species, particularly Coleoptera and phytophagous Hymenoptera which develop directly in the wood or beneath the bark of logs.

b) Among the parasitic Hymenoptera there is a series of species which prey upon these xylophagous beetles and other Hymenoptera. Very similar to these are certain predatory forms, especially beetles which depend upon particular host species for food.

c) There are further many mycetophagous species, mainly beetles, which develop in the several types of fungi regularly associated with decaying wood. These likewise support a series of parasitic forms.

These three ethological groups we may regard as constituting a primitive fauna which has long been characteristic of wood. A small proportion occur in living trees, but such a great majority live in the wood of moribund or dead trees that we must believe the latter habitat to present the most primitive one. In the case of the mycetophagous types this is still more evident.

d) A secondary fauna includes first a number of predatory insects which are not like the parasites and predators previously referred to, associated with particular hosts, but find simply a convenient source of food supply in the xylophagous fauna.

e) Other members of the secondary fauna include various insects, such as wasps and bees that find suitable nesting sites in burrows in the wood. Although such habits are firmly fixed in one or two families, they are clearly not of primary general significance.

f) Finally, as in any biocœnose there are forms on the borderland whose occurrence is either wholly chance, or at least very occasional and due to sporadic combinations of circumstances that do not occur with sufficient regularity to support species unable to breed elsewhere. An example of this condition is seen in the species Drosophila listed above which breed under bark only where the latter is wet and fermenting due to the presence of yeasts.

Three of the more extensive orders of holometabolous insects, the Coleoptera, Hymenoptera and Lepidoptera are very generally associated with trees although by no means exclusively so. This is particularly true of the Coleoptera which is of the three without question the oldest from a geological standpoint. As was hinted at the outset it seems quite apparent that the Hymenopterous fauna gives evidence of long association with trees and as will be shown in a moment the same appears to be true of the other orders. This implies a rather lasting and unchanging environment.

Contributory to a continuity of fauna is the uniformity of conditions within the woody tissue. The material composition of the wood and bark varies only to a very limited extent and these offer the same food materials, supplied with water in far more constant proportions than food materials that are temporarily or permanently affected by drought or superabundant moisture. Aside from climatic changes and seasonal fluctuations the temperature variations of such an environment are of quite different order from those to be encountered in the course of a free and active existence in the open. In all, the conditions of life in wood are conducive to conservatism as they offer few incentives for progressive adaptations. There is no question that these facts have had a profound influence upon the rapidity of evolution of the insects concerned. Consequently, we find at the present day many primitive types persisting as relicts of an earlier xylophagous fauna still associated with woody tissue and still retaining a primitive series of parasitic enemies, at least among the Hymenoptera. With this fauna are other insects that have adopted this habitat more recently and some of these very patently represent acquisitions derived from other habitats.

These points may be readily clarified by the citation of examples taken from several orders of insects. Indeed, a very representative series might be drawn from the present small collection without having recourse to other well known instances. Among the several extensive and diversified modern orders of insects, including the Coleoptera, Lepidoptera, Hymenoptera and Diptera, all of which are traceable to an origin from an earlier Mecopteroid type the occurrence of dendrophily is well marked in several of the primitive families. Among the Trichoptera wood-boring larvæ are of rare occurrence, no doubt by reason of the fact that the developmental stages are almost without exception aquatic. However, in the other orders there are numerous and widely scattered examples of xylophagous habits, and with the exception of the Coleoptera, the wood-boring forms are mainly members of the more primitive families. A reason for the general absence of the more primitive beetles in this habitat is not far to seek since this group is the oldest of the series. It is represented by several types in the Upper Permian and in the Upper Trias had become quite prevalent, so that if the association of beetles with trees dates from this time or later there were various types of Coleoptera extant. The oldest Hymenoptera known have been found in the Upper Jurassic and are very similiar to living members of the archaic family Siricidæ[1] Whether the order existed in the Upper Permain appears very doubtful, as the only insects so far discovered which appear to be in any way related to the modern Hymenoptera are the order Protohomoptera found by Tillyard in the Upper Permian of Kansas. Insects supposed to be Lepidoptera have been reported from the Middle Jurassic but these have been shown without question to be Homoptera, so that no Lepidoptera are actually known earlier than the Tertiary. This is obviously due to incomplete knowledge and to judge from their food relations at the present time as outlined in the present account, it seems probable that the Lepidoptera were present in the Liassic and probably in the Triassic. This order is thus apparently older than the Hymenoptera but of more recent origin than the Coleoptera. The Diptera are well represented in the Upper Liassic,

[1] Since the above was written I have received a paper by Martynov (Bull. Acad. Sci. Russie, vol. 19, 1924) in which several remarkable Hymenoptera are described from Jurassic deposits in Turkestan. These include a very primitive type of sawfly, an oryssid-like genus and a member of the family Heloridæ. These discoveries offer strong confirmation of the views expressed in the present paper.

but only by clearly primitive nematocerous types (except for one typical Xylophagid). We may therefore safely conclude that this order had its origin after the Permian in the Liassic.

With these facts in mind, as gleaned from the paleontological data so far accumulated, we may inquire more in detail concerning the occurrence and distribution of xylophagous habits in these several orders.

In the Lepidoptera there are several very generalized families which form the suborder Homoneura. Of these the small but widely distributed family Hepialidæ includes large moths most of which develop in burrows that they excavate in wood, while others are subterranean and feed upon the roots of trees. Although not entirely lignivorous, it is interesting to note that the most primitive of all families belonging to the Homoneura, the Micropterygidæ includes species that mine in the leaves of trees as well as forms that feed upon more primitive plants such as mosses and liverworts.

Another primitive family, the Cossidæ, includes large moths which are xylophagous as larvæ, and as typified by members like the Leopard Moth (Zeuzera) and Carpenter Moth (Prionoxystus) are notoriously destructive to certain deciduous trees. Likewise the related family Sesiidæ (Aegeriidæ) restrict their diet to the wood of trees except in rare instances where a few species have become secondarily associated with herbaceous plants. These several families are all internal feeders and true wood-borers, but even in the case of one family which feeds on foliage, the leaf-rolling Tortricidæ, the selection of trees rather than herbaceous plants is very marked. Another series which exhibits the same predilection for trees is the enormous family Geometridæ. These are however not so important from the present standpoint,for although quite generalized they are by no means so primitive as the other families mentioned.

Among the Hymenoptera the case is still clearer for the most primitive groups not only of phytophagous types but of parasitic ones as well are definitely associated with the woody flora. There is some ground for a difference of opinion in selecting the most primitive living type of Hymenoptera and also in indicating the probably phylogeny of the lower groups. On the basis of wing venation and many anatomical structures it seems probable that the families Xyelidæ and Pamphiliidæ represent the most primitive type related to forms from which the present-day Sawflies (Tenthredinidæ *et al.*) have been derived. They as well as the sawflies are typically associated with trees although they are leaf-feeders and not xylophagous. From them also probably have come the wood-wasps, typified by the very generalized Xiphydriidæ and the Siricidæ. From a paleontological standpoint the Siricidæ might appear to be the oldest Hymenoptera as the only clearly preserved members of the order known before the Tertiary are some upper Jurassic Siricidæ that occur in the Solenhofen lithographic stone.[1] This is very scant evidence, however, and indicates only a lack of knowledge as the early Tertiary, especially the Lower Oligocene sees the Hymenoptera as diversified and almost as modern in type as at the present day. Nevertheless, the Siricidæ clearly represent the remnants or offshoot of a group which gave rise to an important and extensive series, the Parasitic Hymenoptera, which include a considerable number of families and a vast number of genera and species. The parasitic habit is first manifest in the entomophagous Oryssidæ and in them we find still an association with wood boring insects, as Oryssus is known regularly to live in wood and has recently been found to be an ectoparasite of beetles belonging to the family Buprestidæ. The Oryssidæ have been considered as forming an independent superfamily, but most hymenopterists agree in associating them with the Siricidæ. There can be no reasonable doubt that they have arisen from the siricoid stem, as well as that they represent the most primitive parasitic group in the order. Among the other parasitic Hymenoptera, the Aulacidæ (exclusive of Evania and its allies) show a number of similarities to the Oryssidæ of such nature that we must consider them related, and as the Aulacidæ are the most primitive of the Ichneumonoidea we find this vast group clearly brought forth by xylophagous ancestors. The only other group of Icheneumon-flies that retains the costal cell which disappears in the higher forms, is the Stephanidæ. Little is known of their habits, but their association with trees leaves little doubt that they are parasites of wood-boring insects. The same is true of the peculiar family Megalyridæ known only from Australia and South America and representing an archaic type most likely another derivative of the Siricoids. Among the two dominant present day families of ichneumon-flies, the Ichneumonidæ and Braconidæ we find the more primitive smaller groups of each to be parasites of wood-boring insects, e. g. the *Rhyssini* of the former family and the Spathiinæ, Hormiinæ and Helconinæ of the latter. Several other families have similar habits but these are much more highly specialized types, except perhaps the remarkable genus Ibalia. This is usually considered to be an aberrant Cynipid but it shows affinities with the Siricidæ, upon which it is parasitic, and is without question a relict of some primitive group.

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[1] See footnote on page 87.

From the foregoing it is evident that the association of the orders Hymenoptera and Lepidoptera with trees, especially with the wood of the latter is clearly marked in the most primitive families, in fact we may be almost satisfied without further evidence that these two large and diversified orders arose as lignivorous forms. This can hardly be true of their earlier ancestral type, the Mecoptera, nor of the more primitive Mecopteroid derivatives, the Trichoptera. This forms strong contributory evidence that the Hymenoptera and Lepidoptera had an origin coincident with that of the modern ligneous flora. The origin of the Coleoptera at an earlier time before this flora had developed resulted not in an association of the more primitive adephagous beetles with trees, but in the appearance of the lignivorous habit in some of the most highly specialized Celeoptera such as the Cerambycidæ and Ipidæ (Scolytidæ). Some other families like the Buprestidæ have similar habits, but they represent by no means the most generalized members of the order. With the Diptera the rather sparse occurrence of wood boring forms offers little suggestion that the earlier types may have been associated with trees. Obviously the degenerate mouthparts of the larval dipteron are not well suited to chewing wood, even in the more primitive nematocerous forms and only occasional types have become dependent upon the woody flora.

FOUR NEW HELMIDÆ FROM CUBA, WITH NOTES ON OTHER WEST INDIAN SPECIES[1]

By P. J. Darlington, Jr.

In common with all but the most thoroughly worked parts of the world the West Indies have yielded to entomological collections only a very small fraction of their probable Helmid fauna, indeed only one species of the family is at present recorded from that entire series of islands. It was with particular pleasure, therefore, that four apparently undescribed species of *Helmis* were collected during the eight weeks which I was privileged to spend, during the fall of 1926, at the Harvard Biological Laboratory on the Soledad sugar "central", near Cienfuegos, southern Santa Clara, Cuba. The genus was first noted on Oct. 19, when two specimens were taken on a stone secured from the bed of the Arimao River. The same locality was visited again on Dec. 3, and two hours of back-breaking work in from six to eighteen inches of swiftly flowing water, just above the point where the current broke into a series of minor rapids, yielded twenty-nine specimens, including all the species obtained. Finally, a single specimen was discovered in going over alcoholic material collected Nov. 24, along a gravel bar of one of the larger tributaries of the Arimao.

These species have definite affinities with others occuring in the southern United States, notably in Texas, but all have equally definite distinguishing characters of specific value. As far as I can judge from the descriptions and plates in "Biologia," none of the described Mexican and Central American species are very closely allied to the Cuban ones, a finding which is in agreement with the general conclusions reached by Leng and Mutchler in their preliminary list of West Indian Coleoptera. In order to establish relationships, specimens or descriptions of all the species listed from America north of Mexico by Mr. Leng have been examined.

The Cuban species are only moderately closely related

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 283.

among themselves, but are mutually congeneric according to the characters in use at present. There is considerable variation in the width of the prosternum between the coxæ, but this seems to have no generic value, and is often at least partly due to superficial lateral dilation of the sternum over the edge of the coxa rather than to a change in the insertion of the latter. In *Helmis simplex*, here described, which has a very broad prosternal process, no pubescence is apparent inside the front tibiæ, and, if the form were not almost exactly that of *H. ferruginea* Horn, the species might be referred elsewhere. The four species agree in having eleven-jointed antennæ with the second joint moderately and regularly enlarged, in having the last joint of the maxillary palpus moderately elongate, and in having the last ventral segment of all specimens curiously emarginate, the emargination having removed a narrow, semi-circular strip from the edge of the apex of the segment, leaving the actual apex unchanged in form but causing the sides to appear lobed or toothed. This character is variable from species to species, but the difficulty of describing it has rendered its use inadvisable at present. An attempt has been made to select only the more useful characters for mention in the descriptions, and to avoid the repetition of statements which have been made in the discussion.

For comparative purposes the key which precedes the descriptive portion of the paper has been constructed to include *Helmis smithi* Grouvelle, which I know only from the literature, and the two Texas species *H. cæsa* Lec. and *H. ferruginea* Horn, of which I have seen the type and authentic specimens, respectively, in the Museum of Comparative Zoölogy. I must express my thanks to Mr. Banks and the authorities of the museum for permitting me to examine these and many other specimens, and I must also thank Dr. Thomas Barbour and Dr. W. M. Wheeler for arranging my Cuban trip, and Mr. R. M. Grey and other friends at Soledad for helping to make my stay profitable and enjoyable.

Key: Cuban and related species.

1. Pronotum with a pair of sublateral, elevated carinæ paralleling the lateral margins; palpi pale; intercoxal portion of prosternum about half as wide as that of mesosternum. 2

Pronotal disk without carinæ or definite impressions; palpi infuscate; intercoxal portion of prosternum nearly as wide as that of mesosternum. . . . .*Helmis simplex* n. sp.

2. Pronotum strongly, transversely impressed at middle.. . 3
Pronotum longitudinally, not transversely, impressed.. . 4

3. Basal half of pronotum granulate, opaque. . . . .
H. minima n. sp.
Pronotum entirely shining, not granulate; prothorax more narrowed at base; size a little larger; (Texas). . . . .
H. cæsa Lec.

4. Elytra together nearly twice as long as wide; pronotum darker than elytra. . . . . *H. filiformis* n. sp.
Elytra together about one and a half times as long as wide; pronotum never darker than elytra. 5

5. Sublateral carinæ reaching anterior edge of pronotum. . . 6
Sublateral carinæ abbreviated anteriorly; (Grenada).
H. smithi Grouv.

6. Ferrugineous; larger and proportionately broader; prothorax more narrowed at base; prosternum broader between the coxæ; (Texas). . . . . *H. ferruginea* Horn.
Elytra usually slate-colored. . . . . . . *H. quadrata* n. sp.

Helmis minima n. sp.

Elongate, parallel, slightly depressed; piceous black, pronotum and front darker; abdomen, antennæ, legs, and labrum rufous; palpi pale yellow. Head moderately shining, faintly punctured and pubescent. Prothorax subquadrate, hardly as wide as long, slightly and regularly narrowed at apex and, very slightly, at base; sides otherwise nearly parallel; lateral margins finely crenate; disk with complete, transverse median impression, and with a pair of fine sublateral carinæ paralleling the side margins from base to apex, the distance between them being somewhat more than half the discal diameter; area before transverse impression shining, finely and sparsely pubescent; area behind impression dull, granulate. Elytra together a little less than twice as long as wide, very little wider than the thorax, the sides straight and very slightly divergent from just back of humeri to apical fourth; outer margin obsoletely crenate; disk sparsely punctured and pubescent; fifth interval with a fine carina from base nearly to apex; third interval not prominent at base; basal two thirds of four inner striæ represented by irregular series of punctures; a faint alutaceous sculpture visible near the larger ones. Length 1.3-1.4 mm. Width 0.45 mm. Holotype and three paratypes, Arimao River, Soledad, Cienfuegos, Cuba, Dec. 3, 1926.

One specimen, from the gravelly bank of a large brook, Nov. 24, has the head less shining, the thoracic and elytral margins more clearly crenate, and the elytral striæ longer; I have referred it to this species, but not as a paratype. With this exception, there seems to be no noteworthy variation. The form is almost exactly that of *H. cæsa* Lec. from which it differs chiefly as indicated in the key. In this, as in all the following species, no sexual characters have been noted, and the size is really remarkably constant. The holotype, with the three of the other species, is in my private collection, and at least one paratype of each form described will be retained to lend to established students. Paratypes of all species will be deposited in the Museum of Comparative Zoölogy and the National Museum; of *filiformis* and *simplex*, in the American Museum.

Helmis filiformis n. sp.

Elongate, parallel, slightly depressed; dilute brown, with slaty tinges below and on elytral disk; head and pronotum dull black; antennæ, tarsi and palpi yellowish rufous. Head opaque, moderately punctate and pubescent. Prothorax subquadrate, about as long as wide, widest one third from base, slightly narrowed at base and apex; side margins slightly crenate; pronotum longitudinally impressed on median third, the impression indicated at base by a pair of minute carinæ; pronotum also with a pair of complete, sublateral carinæ paralleling the side margins anteriorly, but sinuate and slightly approaching the margins posteriorly, the distance between them being more than half the discal diameter; disk alutaceous or finely granulate, more distinctly so posteriorly, sparsely punctate and pubescent; elytra together nearly twice as long as wide, very little wider than the thorax, with the margins straight and very slightly divergent from just back of the humeri to apical fourth; outer margin finely crenate; fifth and seventh intervals elevated to about apical fourth; third interval more prominent basally than second or fourth; four inner striæ represented by stripes of irregular, dense alutation, obsolete on apical fourth; disk dull, sparsely pubescent. Length 1.8-1.9 mm. Width 0.6 mm. Holotype and six paratypes with same data as preceding species. Two paratypes from same locality, Oct. 19.

There is some variation in the degree of infuscation of the elytra. The general habitus is that of the preceding species, though perhaps a trifle more elongate.

Helmis quadrata n. sp.

Moderately stout, subparallel; slate-gray, abdomen and particularly pronotum with a reddish brick-colored tinge; tarsi and antennæ rufous; palpi yellowish rufous. Head dull, with small scattered black granules. Prothorax subquadrate, barely wider than long, widest about a third from base; slightly narrowed behind, more narrowed in front; lateral margins crenate; pronotum with a median longitudinal groove from base nearly to apex, the groove limited by two short carinæ at base; pronotum also with a pair of complete, sublateral carinæ parallel with the sides in the apical half but sinuate and slightly approaching the margins toward the base; distance between carinæ more than half the discal diameter; disk dull, finely and sparsely pubescent, not evidently granulate. Elytra together about a half longer than wide, a little broader than the thorax; margins inconspicuously crenate; intervals five and seven with granulate, elevated costæ reaching to about apical fourth; third interval prominent at base; four inner striæ represented by narrow, irregular grooves; first at least indicated to apex; disk dull, finely and sparsely pubescent. Length 1.9-2.1 mm. Width 0.8-0.9 mm. Holotype and four paratypes with same data as *H. minima*.

This species, too, is very constant in essential characters. In one specimen the reddish shade of the pronotum is diffused over the elytra, enhancing the resemblance to *ferruginea*, from which it differs principally as indicated in the key. The prosternum seems to be slightly broader between the coxæ in that species, and the median groove of the pronotum is much less distinct at base.

Helmis simplex n. sp.

Moderately stout, subparallel; dull black, with a pinkish-gray tinge below; tarsi, trochanters, and antennæ rufous, latter a little paler toward the base; palpi infuscate. Head dull, with scattered dead-black granules on a uniformly muddy background. Pronotum barely wider than long; sides subparallel, slightly more narrowed in front than behind; disk regularly convex, without carinæ, and with the barest trace of a longitudinal impression at base; disk evenly, sparsely, and finely punctate and pubescent. Elytra together about one half longer than wide; four inner striæ almost completely obsolete; third interval not prominent; disk finely and sparsely pubescent, opaque, smooth near the suture, with several rows of granules externally the most prominent on the seventh interval. Length 1.9-2.0 mm. Width 0.8 mm. Holotype and twelve paratypes with same data as *H. minima.*

The most distinct and perhaps the most constant of the four species described. The affinities are probably toward *H. quadrata*, the general form of which is closely imitated, but the relationship is not very close in other ways.

After the preceding portion of the paper had been completed, a small lot of West Indian *Helmis* was received for study through the kindness of the authorities of the United States National Museum. Of the three species involved, one, represented by three specimens labeled "Grenada, W. I., Aug. Busch Collector" is undoubtedly *H. smithi* Grouvelle, described from the same island in 1898 (Notes fr. Leyden Mus., XX, p. 47). This insect is closely related to *H. ferruginea* Horn, but is separable as previously indicated. The difference in the thoracic carinæ is not very marked, but is supplemented, as Grouvelle said, by one in the median, longitudinal groove of the pronotum, which is longer in *smithi*. The two other species are both from Jamaica collected by H. G. Hubbard, and are very close to the species described above as *minima* and *filiformis*, of which they seem to be at best no more than geographical varieties. The form near *minima* is represented by a single specimen, 1.5 mm. long, which seems almost exactly typical in shape and sculpture, though the latter is slightly obscured; that near *filiformis*, however, seems subspecifically distinct.

Helmis filiformis jamaicensis *n.* subsp.

Almost precisely as in typical *filiformis* except as follows: the color above is practically uniform, ranging from dull rufous in the holotype to piceous in the darker paratype. In the latter there are vague rufous areas near the humeri, but these do not suggest the straw-colored elytral ground of typical *filiformis*. The median longitudinal groove of the pronotum is slightly finer and not as abbreviated as in the Cuban form. The size is slightly greater, the three specimens being between 1.9 and 2.0 mm. in length. The holotype and two paratypes belong to the collection of the National Museum. The type is No. 40350 in the collection of the U. S. National Museum.

ÆGIALIA ARENARIA MULS. IN NEW ENGLAND, WITH LOCAL RECORDS FOR OTHER SPECIES[1]

By P. J. Darlington, Jr.

On Apr. 4, 1925, the writer took over three hundred specimens of the European *Aegialia arenaria* Muls. crawling on the sun-heated sand of the dunes and, especially, of the beach near Ipswich, Mass., where it was evidently thoroughly established. In general form this species resembles *A. opifex* Horn, but is stouter and much larger, about five mm. in length. It may be at once distinguished from all our previously known species by its virtually impunctate pronotum and greatly reduced inner wings, which are not over half the length of the elytra and which are thin and unsuited for flight. Later in the season, notably May 22, 1926, it was found on the sand more sparingly, and was taken under deeply buried logs a little above tide line. The species was more common on the beach proper than on the adjacent higher dunes, while the exact opposite seems to be true of the functionally winged *A. opifex*, a species which has been taken in numbers at the same locality in May, but not at all in April. The first difference may be explained as a specific ethological preference or by the fact that the awkward, flightless *arenaria* is blown off the heights which its more active relative easily attains The ethological explanation is the more satisfactory, for all our other New England species range inland, while this is apparently unwilling or unable to leave the coast. *Arenaria* is, however, frequently seen rolling along the sand before the wind, and is occasionally blown into the ocean and washed into the local drift.

Whether this species, now locally so common, is introduced or native it is impossible to say at present, but it is difficult to see how a flightless species of its habits could have crossed the Atlantic to such a comparatively remote point as Ipswich. The species seems to be quite absent on the beaches near Lynn, which is much nearer Boston than is the region in which it occurs, though I have searched as thoroughly in one place as the other. It seems significant that the range of the species in Europe, the entire northern area and Great Britain, is similar to that of many plants which are known to be native both there and in America, and it is notorious that maritime species are wide ranging. It is not easy to see, however, how our many enthusiastic local collectors, past and present, could have entirely missed the species, though perhaps the facts that the spring flight, so called, is exceptionally early, that the insect is less conspicuous later in the year, and that it is flightless and not apt to straggle into more frequented regions may have contributed to its invisibility. The larva, of course, must inhabit the same region as the adult, and must be buried in the sand to escape the heat of the sun, so that it is even less likely to be discovered or transported than the adult. Several other beetles more or less common at Ipswich are poorly represented in local collections, and the few representatives are usually from localities to the south. If it can be shown that *arenaria* exists at more northern stations and if it does not turn up further south, we shall be able to see how it at least might have been overlooked in the past. Botanical evidence indicates that, if the species is naturally of transatlantic distribution, it should occur in the Gulf of St. Lawrence region.

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 284.

The determination of the Mass. specimens depends on comparison with one from Europe in the Museum of Comparative Zoölogy and on reference to the literature. There seems to be no other European species with which the present one could well be confused.

In addition to *A. arenaria*, five species of the genus occur in New England, one of which appears to be at present unrecorded. *A. blanchardi* Horn, *spissipes* Lec., *opifex* Horn, and *rufescens* Horn are all found in eastern Mass., while the last two have been taken in central N. H. as well. A single specimen of *A. lacustris* Lec. was taken at Paris, Me., July 9, 1915, by Mr. C. A. Frost, and has been compared with the type. Another unique, also of *lacustris*, but leaning a little toward *cylindrica* Esch., was taken by the writer under a stone in Tuckerman's Ravine, Mt. Washington, N. H., Sept. 10, 1926, at about 4,000 ft. elevation. For the final determination of this specimen I am indebted to Mr. H. C. Fall. The previously known range of *lacustris* includes Nfld. and Mich.

NEW SPECIES OF SCATOPHAGIDÆ.

By Charles W. Johnson

Boston Society of Natural History.

Amaurosoma Becker.

This genus is characterized by having three sternopleural bristles, the first vein without bristles; arista slightly pubescent and the fore femora armed with a series of closely placed bristles on the anterior and antero-ventral surfaces.

The following is a table of the New England species. The three species described by Malloch from Alaska in 1920 (Ohio Jour. Sci., XX, 284), and later tabulated (Bull. Brooklyn Ent. Soc., XVII, 77, 1922) are omitted.

Table of species.

1. Thorax and abdomen black, grayish pollinose, propleura hairy.?...2.
   Thorax, head and abdomen yellow, propleura nude........ *nuda* Mall.
2. Wings uniformly hyaline. ....3.
   Wings with the anterior half brownish...*brunneicosta* sp.nov.
3. Antennæ black, abdomen subshining with hairs partly black, ventral part of the genital armature black, legs yellow, tarsi brownish...................*acuticornis* Loew.
   Antennæ with the first and second joints yellowish, abdomen dull, with white hairs on all the segments, ventral part of the genital armature yellow, legs entirely light yellow.... *pallidipes* Mall.

Amaurosoma brunneicosta sp. nov.

Face and cheeks yellowish white, lower half of the front yellow, the upper part black, orbits, vertex and occiput grayish pollinose, three orbital and two small frontal bristles; antennæ black, the base of the third joint yellowish, basal half of the arista thickened, proboscis black, palpi white, slender. Thorax and abdomen black, covered with a grayish pollen, hairs black, lower part of the pleura with long white hairs, scutellum bearing two bristles. Legs yellow, the anterior femora with a row of five bristles on the anterior surface. Costa and all the veins to and including the fourth, together with that portion of the wing brown, the posterior portion of the wing hyaline and the veins light yellow, Squamæ and halteres light yellow. Length 4 mm.

Echo Lake, Mt. Desert, Me., June 27, 1922. Holotype in the collection of the Boston Society of Natural History.

Amaurosoma acuticornis (Loew).

Cordylura acuticornis Loew, Cent. IX, 94, 1869.

Specimens agreeing with the type have been collected by the writer at Jaffrey, N. H., May 14-20, and June 3; also at Rutland, Mass. June 5. Mr. S. A. Shaw has taken the species at Hampton, N. H., May 12 and 18.

Orthacheta Becker. (*Orthochæta* as amended).

This genus has three sternopleural bristles, the first vein bristly on the outer half, hairs of the arista short, scutellum with four bristles. The following is a table of the New England species, based on the males, with the exception of *O. strigipes* based on a female from Colorado.

Table of species.

1. Front black, middle and hind coxæ black, abdomen subshining with a slight bluish gray pollen. . *dissimilis* Mall.
   Front partly yellow, all the coxæ wholly or partly yellow, abdomen with a dull gray pollen. 2.
2. Wings and veins brown except at the base, lower third of the front yellow. *brunneipennis* sp. nov...
   Wings and veins yellow, front yellow, the upper third black 3.
3. Coxæ of the middle and hind legs dark, a stripe on the posterior side of the front and middle femora black. . . . . *strigipes* sp. nov

Coxæ and femora entirely yellow. . . . .

4. Abdomen entirely black, the genitalia partly dark brown, the ventral genital armature black, hairs of the legs long. *hirtipes* sp. nov.

Abdomen black above, lateral margins of the segments venter and genitalia reddish brown, hairs of the legs short. *cornuta* Loew.

Orthacheta brunneipennis sp. nov.

Face, cheeks and lower part of the occiput white, the lower third of the front yellow, the remainder black, frontal orbits white, bearing five bristles, upper part of the occiput black covered with a grayish pollen; antennæ black, the tip of the second joint yellowish, proboscis black, palpi white. The thorax and abdomen black and covered with a grayish pollen, on the dorsum of the thorax slightly brownish, the rows of fine dorsocentrals give the appearance of two narrow dark lines; genitalia black, legs yellow, the posterior tarsi entirely black, the fifth joint of the fore and fourth and fifth of the middle tarsi black. Wings brownish, the extreme base a little lighter. Halteres yellow. Length 6 mm.

The female differs in having the wings yellowish with the vein brown; abdomen black with the last segment sometimes brownish at the tip; hind coxæ slightly darkened at the base.

Holotype and allotype taken near the "Ark", Jaffrey, N. H., May 18, 1925, and six paratypes from the same locality, May 16-June 5 in the collection of the Boston Society of Natural History. One paratype Hull, Quebec, June 6, 1923, (C. H. Curran) in the Canadian National Collection, Ottawa; two Jaffrey, N. H., May 21 and June 5, in Museum of Comparative Zoology and two Jaffrey, May 21, in the author's collection.

Orthacheta strigipes sp. nov.

Face white, front yellow, the upper third and sides blackish, orbits narrow, white, margined with dark gray, bearing seven bristles; occiput black grayish pollinose; antennæ black, the tip of the second joint narrowly margined with light yellow, palpi light yellow. Thorax and abdomen black, dark grayish pollinose. Legs yellow, the front and middle femora with a black stripe on the posterior side, on the middle femora confined to the outer half, base of the middle and posterior coxæ, and the middle and posterior coxæ, and the middle and posterior tarsi black, the front tarsi yellow the fifth joint black. Halteres and wings yellow, Length 6 mm.

One female, Colorado, in the author's collection. This species closely resembles *Cordylura vittipes* Loew and may be confused with that species unless the generic characters are closely studied. The New Mexican record for *C. vittipes* may refer to this species.

Orthacheta hirtipes sp. nov.

Face and cheeks white, front yellow, the upper third brownish black, orbits gray the lower part white, six orbital bristles, vertex and occiput black, grayish pollinose, antennæ black, outer half of the second joint yellowish, palpi light yellow, hairs black. Thorax and abdomen black, grayish pollinose, upper part of the genitalia dark brown, the ventral genital armature black. Legs yellow, the posterior tarsi brown, the fifth joint of all the tarsi black, the hairs on the legs longer than in the other species, hairs on all the coxæ black. Halteres yellow, wings yellow, hyaliue, veins brown. Length 6 mm.

On male, Mt. Washington carriage road, 2500 ft., June 14, 1916, (C. W. J.). Type in the collection of Boston Society of Natural History.

Orthacheta cornuta (Loew)

Cordylura cornuta Loew, Cent. III, 48, 1863.

This species has been taken at the following places in New England. Bar Harbor, Me., June 13; Framingham, Sherborn, Auburndale and Arlington, Mass. May 16 to June 18.

NEW MEGACHILID BEES.[1]

By Theodore B. Mitchell,

The species which are described below were found in two series of unidentified material, one in the collection of Professor W. M. Wheeler at the Bussey Institution, and the other in the collection of the Museum of Comparative Zoology at Cambridge.

Lithurgus bruesi n. sp.

♂. Head broader than long, the eyes converging slightly below, pubescence entirely greyish-white; supraclypeal plate shining, almost impunctate medially, with scattered punctures laterally; clypeus impunctate medially except for a few scattered punctures, but closely punctate laterally, practically rugoso-punctate, the apical margin smooth and entire; labrum very peculiar and distinctive, having a deep longitudinal impunctate channel or concavity, which has on either side midway a strong triangularly pointed spine, the distance from the bottom of the concavity to the tip of the spine being equal to about half the length of the labrum; mandibles ordinary, with three subequal teeth; cheeks about as broad as width of eye, the posterior margin above quite sharp but hardly carinate, closely and finely punctured; vertex slightly rounded, closely and rather finely punctured, the punctures between the eyes and ocelli large, deep and distinctly separated; lateral ocelli very slightly nearer edge of vertex than to nearest eye; antennæ shining above, dark, the joints more ferruginous apically, dull brownish-red below, the joints slightly longer than broad, the first joint of the flagellum and the basal half of the second joint, below, blackish.

Thorax with pubescence entirely greyish-white, longer at sides and behind; mesonotum and scutellum extremely densely and quite finely punctured, the punctures of the pleura also being very close and quite fine; propodeum with minute close punctures laterally, more sparse behind, the surface tessellate, basal triangle not definitely demarked; tegulæ ferruginous, impunctate, white pubescent anteriorly; wings lightly and rather uniformly fuliginous, slightly paler apically, nervures piceous to black, basal nervure well beyond transverse median, the recurrent nervures entering the second submarginal cell at about equal distances from base and apex; legs black, with long white pubescence, the tarsi tinged with red, the metatarsi very long and slender; spurs pale testaceous; claws ferruginous, darker apically, deeply cleft, pulvilli distinct.

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[1] Contribution from the Department of Zoology and Entomology, North Carolina State College, in cooperation with the Entomological Laboratory of the Bussey Institution, Harvard University (Bussey Institution, No. 273). Published with the approval of the Director of the North Carolina Experiment Station as paper number 15 of the Journal Series.

Abdomen black, tinged with red basally, the basal segments almost impunctate, the apical segments finely punctured, segment 6 quite closely so; pubescence pale on segments 1 and 2, short and fuscous on segments 3-5, long and fuscous on 6 and 7; segments 2-6 with apical fasciæ of white pubescence, widely interrupted on 2 and 3, slightly so on 4, entire on 5 and 6; ventral segments 2-5 also with distinct entire white apical fasciæ and with long white pubescence on the discs. Length 12 mm.

Type: Male (Type No. 15710, Mus. Com. Zool.); Austin, Texas (C. T. Brues, collector).

With the mandibles closed this would be easily mistaken for *L. echinocacti* Ckll., but with the labrum exposed it is easily distinguished. This distinguishes this species at once from all the other North American species.

Megachile austinensis n. sp.

♀. Head broad, eyes subparallel; supraclypeal plate shining, very sparsely punctured medially, closely so at sides and above; clypeus almost impunctate in center, with a few widely scattered minute punctures, the surface polished, punctures coarse and quite close on extreme sides, apex entire, deeply impressed just before the edge which is slightly grooved; mandibles reddish above, black on the three inner teeth, with scattered, coarse, striate punctures above, 4-dentate, the two outer teeth broadly rounded, the third one acute and the inner one subacute; cheeks quite broad, finely and closely punctured, the punctures rather shallow below, deeper above, pubescence quite thin and short, white; vertex quite finely punctate, the punctures well separated, surface finely tessellated between the punctures, pubescence long and thin, pale, with some short inconspicuous black hairs intermixed; lateral ocelli about equally distant from eyes and edge of vertex; front below ocelli well punctured, but the punctures not crowded; antennæ apparently reddened (both are broken, only the stub of one flagellum left); pubescence below anterior ocellus white and quite dense, clypeus nearly bare, with some inconspicuous yellowish hairs at sides.

Thorax white pubescent except above, mesonotum with at least some dark pubescence (rubbed), and apparently also the scutellum; mesonotum rather dull, punctures quite small, close laterally and somewhat so anteriorly, sparse in center, the surface finely tessellated; scutellum with fine, widely separated punctures; pleura with crowded, rather fine punctures above, becoming coarser below; propodeum tessellate, with numerous fine and indistinct punctures, basal triangle granular; tegulæ dark ferruginous, minutely but fairly closely punctured; wings faintly infuscated, darker apically, nervures piceous to brownish, second recurrent nervure entering second submarginal cell slightly nearer apex than the first does to base; legs dark red, white pubescent, yellow on tarsi beneath, middle and hind metatarsi not quite as broad as their tibiæ, the middle ones with rather long stiff whitish pubescence exteriorly, front metatarsi with a thin but long fringe posteriorly; spurs reddish-testaceous; claws reddish-testaceous basally, brighter red apically, with short and sharp basal setæ, almost toothed.

Abdomen cordate, apical segments shining, punctures fine, quite close on basal segments, rather sparse on apical ones except the sixth; pubescence short and black, entirely white on segment 1 and white basally on segment 2; segments 1-5 with entire conspicuous apical white fasciæ, narrow on segments 1 and 2, broader on 3-5; segments quite deeply impressed apically at sides, but slightly so medially; segment 6 quite broad, closely and finely punctured, slightly but distinctly concave at sides when viewed from above, straight in profile, with an obscure median longitudinal ridge on which the pubescence is black and appressed and best seen in profile, on either side of this the the surface is covered with subappressed white pubescence, while the extreme tip is clothed with dense appressed fuscous pubescence, segment with erect black hairs across the base, conspicuous at sides; scopa yellowish-white, black on segment 6, and with a small tuft of black hairs at extreme sides of segment 5. Length 13 mm.

Type: Female (Type No. 15707, Mus. Comp. Zool.); Austin, Texas, May 8, 1901 (C. T. Brues, collector).

Megachile wheeleri n. sp.

♀. Head broad, eyes subparallel, pubescence greyish-white on face, thin and white on cheeks, long and black or fuscous on vertex, extending down on cheeks for a short distance; supraclypeal plate quite closely punctured, shining spaces between the punctures medially; clypeus with punctures close above and laterally, more separate in middle where the surface is shining, apex entire, smooth and impunctate, thickened on the edge which is slightly grooved; mandibles broad, reddened apically, sparsely punctate above, 4-dentate, the three apical teeth subequal in size and rounded, the inner one acute, a slightly incurved bevelled edge between the two inner teeth; cheeks about as broad as eye, shining, the punctures rather large but shallow, quite close, finer, closer and deeper above; vertex shining, nearly flat, with punctures well separated in general, close along edge behind ocelli; lateral ocelli slightly nearer edge of vertex than to nearest eye; front below ocelli densely punctured; antennæ black above, obscurely reddened below, middle joints but slightly longer than broad.

Thorax white pubescent at sides and behind, largely black on mesonotum and scutellum, whitish on mesonotum anteriorly and on scutellum posteriorly; mesonotum quite deeply and closely punctured, but the punctures well separated in center where the surface between them is shining; scutellum closely and finely punctate; pleura very closely and finely punctate above, the punctures larger and not so much crowded below; sternum with large, rather close punctures; propodeum with minute indistinct punctures, closer posteriorly, surface rather shiny, basal triangle tessellate; tegulæ ferruginous, yellowish in front, rather closely punctured, the punctures small but distinct; wings subhyaline, clouded apically, nervures piceous to brownish, second recurrent nervure entering second submarginal cell slightly nearer apex than first does to base, but both rather distant; legs black, white pubescent, yellowish on tarsi beneath; middle metatarsi almost as broad as the tibiæ, densely yellowish-white pubescent without; hind metatarsi almost as broad as the tibiæ also; spurs pale yellow; claws pale ferruginous basally, somewhat deeper red apically, basal teeth distinct.

Abdomen ovoid, shining; segments 1 and 2 entirely white pubescent, and segment 3 narrowly white pubescent at base; segments 3-5 with rather long erect black pubescence on discs; segments 1-5 with dense, entire, white, apical fasciæ, very broad on the apical segments, narrow on the first two; punctures fine, close on basal segments, very sparse on the fifth which is highly polished; segment 6 rounded apically and straight at the sides in dorsal view, straight in profile, shining, finely and rather closely punctured, with white appressed pubescence which is dense apically, thinning out basally, and with numerous long, erect, stiff black hairs; scopa white with a very faint yellowish tinge, black on segment 6 and on the apex of segment 5 medially. Length 12 mm.

Type: Female (Type No. 15708, Mus. Comp. Zool.); Alta Meadow, California, altitude 9000 ft., Aug. 23, 1917 (W. M. Wheeler, collector). Paratypes: 4 females, topotypical; 2 females, Calgary, Alberta, Aug. 26, 1925 (Geo. Salt, collector).

This is very close to *M. chrysothamni* Ckll., but in the latter the punctures of the mesonotum are much closer and there are no black hairs on the scutellum. The fifth abdominal segment is much more closely punctured also than in this species. Both of the species described here may be separated from *chrysothamni* by the following key:

1. Clypeus almost impunctate in the center, with very minute widely scattered punctures, but deeply punctate at sides. . . . . *austinensis*
   Clypeus closely and strongly punctured throughout. . . .2.

2. Pubescence of scutellum entirely light; punctures of mesonotum very close throughout. . . . . *chrysothamni*
Scutellum with some long black hairs; punctures of mesonotum distinctly separated in center. . . . . . . *wheeleri*

Megachile inimica jacumbensis n. subsp.

♂. This resembles *M. sayi* Cress. except that the front tarsi are much shorter, the first joint being definitely shorter than the tibia and inclined to blackish along the anterior border; the lateral ocelli are about equally distant from the eyes and from each other; the clypeus has a quite definite though small median emargination; the legs except the front tarsi are black and the pubescence is white.

Type: Male (Type No. 15709, Mus. Comp. Zool.); Jacumba, California, Aug. 17, 1917 (Coll. W. M. Wheeler). Paratypes: 6 males, topotypical; 1 male, Warren, San Diego Co., California, Aug. 13, 1917.

This has been made a subspecies of *inimica* rather than of *sayi* because of the fact that *inimica* was described in 1872 (Trans. Am. Ent. Soc. Vol. 4), and *sayi*, which has been considered the typical form, was not described until 1878 (Trans. Am. Ent. Soc. Vol. 7). In *sayi* s. str. the tarsal scale is much more produced above than in the form here described, and the scale at the anterior margin is fully as long as the tibia. There is also a tendency in *sayi* toward shortening the distance between the lateral ocelli, this being usually somewhat shorter than the distance from the ocelli to the nearest eye or to the edge of the vertex, and the clypeus is not so definitely emarginate medially in the specimens which have been compared.

Megachile spokanensis n. sp.

♂. Head broad, eyes subparallel, pubescence entirely pale ochraceous, with no black hairs, nearly white on cheeks; clypeus closely and finely punctured, apex entire, completely covered with long dense pubescence; mandibles 3-dentate, the middle tooth small, outer margin rounded in the dorsal view, inferior tooth very large, occupying about two-thirds of the inferior margin of the mandible, the outer margin of the tooth long, the inner margin from the apex of the tooth to the base of the mandible much shorter, fringed with short yellowish pubescence, the apex being submedian with reference to the upper surface of the mandible; cheeks fairly broad, shining, finely punctured, the punctures close below, well separated above, lower angle with a rather small bare concavity, but with a robust tooth which is densely pubescent on the apex; vertex slightly rounded, closely and quite finely punctured, the punctures deep, pubescence long and erect, much thinner than on face; lateral ocelli about equally distant from eyes and edge of vertex; antennæ piceous above, somewhat paler below, rather short, the middle joints but slightly longer than broad, the apical one flattened and considerably dilated.

Thorax with pubescence entirely pale, ochraceous above fading to white below, quite long and dense on mesonotum, but not hiding the surface which is deeply and closely punctured throughout; scutellum closely and rather more finely punctured pleura also finely and closely punctured; mesosternum concave, shining, almost impunctate, with two anterior, broad, transversely flattened spines which are rounded apically, one behind each front coxa; propodeum finely punctate, with long, rather dense pale pubescence; tegulæ pale ferruginous, finely and rather closely punctured, pubescent anteriorly; wings subhyaline, clouded apically, nervures brownish, basal nervure slightly beyond transverse median, second recurrent nervure entering second submarginal cell nearer apex than first does to base.

Legs black to piceous, pubescence white, pale yellowish on four posterior tarsi beneath; front coxæ broad, bare, polished, with long, very broad and much flattened spatula-like spines, these incurved on inner apex, the apex narrowed and rounded, no red bristles on the coxæ, the spines long white pubescent behind; anterior femora very strongly keeled, the posterior face being very wide, dark, rather closely and finely punctate, but nearly bare of pubescence, upper face also dark, the antero-inferior face polished testaceous, ferruginous basally and along upper margin; outer face of front tibiæ dark, punctate and white pubescent, testaceous apically, the two inner faces polished ferruginous, the margin between them with a very thin fringe of long pale hairs directed posteriorly; front tarsi moderately dilated, pale yellow, the first joint very deeply hollowed out in front, the outer anterior margin with a short yellowish fringe, the inner one with a longer, more brownish fringe, the scale produced apically over the second joint, looking like the bow of a boat from without, the second joint narrowly produced apically, extending slightly beyond the apex of joint 1, the third joint but very slightly dilated, the fourth not at all, fifth joint somewhat reddened apically, tarsal fringe white, rather yellowish within and tipped with fuscous or black, this evident at the edge of the fringe without; middle and hind legs entirely dark, the middle tarsi not much modified, with basal joint densely white pubescent exteriorly and with a long white hair fringe, middle tibiæ with a bare impunctate area on outer face apically; hind tarsi rather peculiar, the basal joint short and thick, the following ones parallel-sided, hardly at all narrowed at base or widened apically, outer surface strongly convex, the inner surface flat; spurs pale testaceous; claws reddish testaceous basally, piceous apically, rather deeply cleft on the four anterior legs, not so deeply on the hind legs.

Abdomen quite broad, pubescence pale ochraceous, with no black hairs, segments 2-5 with dense apical fasciæ of somewhat more whitish pubescence, punctures fine and close on basal segments, more sparse on the apical segments, which are shining; segment 6 shining, rugoso-punctate above the carina, neither emarginate nor produced medially, but the margin coarsely irregularly and rather sharply denticulate, a median rather deep concavity on the lower surface of the segment, rather coarsely rugoso-punctate on either side of this, the apical margin with two large teeth, one on either side of the middle, these widely separated, sublateral in position, close to the inconspicuous angles which represent the true lateral teeth; segment 7 large and conspicuous, closely and finely punctured, rather evenly rounded, but the apex drawn out into a rather long slender spine; four ventral segments visible, these finely and closely punctured along their bases, the margins shining and impunctate, the fourth segment broadly membraneous and transparent on the apical margin. Length 11 mm.

Type: Male (Type No. 15717, Mus. Comp. Zool.); Little Spokane, W. T., Washington Territory July 26, 1882 (Samuel Henshaw, collector). Paratypes: 1 male, Camp Umatilla, W. T. (across the Columbia River from Umatilla, Ore.), June 26, 1882; 2 males, Alta Meadow, California, altitude 9000 ft., Aug. 23, 1917 (W. M. Wheeler, collector).

This is quite near *M. manifesta* Cress. but in the latter species there are no spines on the mesosternum, the apical spine of segment 7 is much longer, and the hind tarsi are more nearly normal. The inferior mandibular teeth, the front tarsi, and the carina of segment 6 are almost exactly alike in the two species. It is quite possible that this is the male of *M. wheeleri*, since two of these males were caught in the type locality of that species.

Megachile pseudonigra n. sp.

♀. Head broad, eyes parallel, pubescence fuscous, hardly black; supraclypeal plate finely punctured, somewhat sparsely so in center; clypeus very finely and closely punctured above, sparsely and more coarsely so on apical two-thirds, apex entire, with a raised or thickened impunctate edge; mandibles broad, black, obscurely reddish apically, with a very few scattered punctures above, doubly punctate on outer face at base, distinctly 4-dentate, the two apical teeth truncate, the third and fourth acute, a bevelled cutting edge between the latter; cheeks fairly broad, closely punctured above and below, shining above; vertex slightly rounded, punctures close medially, rather widely separated laterally; lateral ocelli about equally distant from eyes and edge of vertex; front below ocelli densely and finely punctured; antennæ black above, obscurely reddish below, middle joints but slightly longer than broad.

Thorax with fuscous pubescence, apparently blacker on surface of mesonotum (specimen somewhat rubbed); mesonotum sparsely punctate medially, closely so laterally and behind, the surface finely tessellated; scutellum closely and finely punctate, and the pleura very finely and closely punctate above, more coarsely so below; propodeum with numerous fine indistinct punctures, tessellate, the basal triangle tessellate or granular; tegulæ bronze-piceous, minutely punctured; wings subhyaline, faintly clouded apically, nervures brownish-testaceous, basal nervure beyond transverse median, second recurrent nervure entering second submarginal cell nearer apex than the first does to base; legs black, pubescence fuscous, tinged with red beneath tarsi and on middle metatarsi without, black on the outer faces of the tibiæ, middle and hind metatarsi fully as broad as their tibiæ; spurs yellowish-brown; claws reddish-testaceous basally, darker apically, with indistinct basal teeth.

Abdomen cordate-ovoid, shining, finely punctate, closely so on basal segments, sparsely so on the apical ones except the sixth, pubescence black, entirely fuscous on segment 1, and segments 2-5 with inconspicuous apical fuscous fasciæ; segment 6 very slightly, if at all, concave at sides in the dorsal view, straight in profile, shining, finely and rather closely punctured, with subappressed fuscous pubescence and numerous erect black hairs; scopa fuscous, shorter and deeper black on segment 6. Length 10.5 mm.

Type: Female (Type No. 15718, Mus. Comp. Zool.); Umatilla, Oregon, June 24, 1882 (Samuel Henshaw, collector).

This would appear to be near *M. vandykei* Ckll., but in that species the pubescence is entirely black, and the clypeus is described as being "densely rugoso-punctate, with a polished shining spot at middle of upper edge, and a median band in which the surface is shining between the punctures, lower margin thickened, slightly emarginate in middle." The clypeus in this species does not answer to that description at all, and the pubescence is fuscous rather than black, with definite though inconspicuous fuscous fasciæ. It may be possible that this is a melanistic form of some light haired species.

Megachile mendica snowi n. subsp.

♀. Head with eyes slightly converging below; supraclypeal plate shining, sparsely punctate medially; clypeus closely and rather coarsely punctured in general, but with the punctures well separated in the center, apical margin entire, the edge thickened and slightly grooved; mandibles black, broad, with a few scattered punctures above, 4-dentate, but the margin between the two inner teeth with a slight angular protuberance, approaching the 5-dentate condition; cheeks quite narrow and quite closely punctured, with short, rather dense, white pubescence; vertex very slightly rounded, the punctures distinct and well separated, surface shining between the punctures, pubescence black, erect, and quite long; lateral ocelli about equally distant from eyes and edge of vertex; front below ocelli densely punctate; antennæ piceous below, somewhat darker above, length of middle joints about one and a half times their breadth; pubescence of face below anterior ocellus white, slightly mixed with black above antennæ, very thin on clypeus.

Thorax with pubescence largely white, but mostly black on mesonotum posteriorly, mixed with white in the middle, and largely replaced by white anteriorly, with some shorter whitish pubescence in the scutello-mesothoracic suture, but this not conspicuous; mesonotum with punctures quite close, more or less separated in center, the surface between them tessellate; scutellum closely punctured, the punctures separated medially, with long black hairs and shorter, softer, white pubescence; pleura with punctures fine and crowded above, larger and distinctly separated below; propodeum tessellate, the punctures very fine and indistinct, basal triangle tessellate below, granular or subrugose above; tegulæ piceous, obscurely testaceous anteriorly, with fine shallow punctures; wings subhyaline, faintly clouded apically, nervures yellowish-ferruginous, second recurrent nervure entering second submarginal cell very near the apex, the first rather far from base; legs piceous to dark red, white pubescent, yellow on tarsi beneath; middle tarsi slightly narrower than the tibiæ, densely pale pubescent without, the following joints but slightly narrowed; hind metatarsi slightly narrower than the tibiæ; spurs pale yellow; claws with distinct basal teeth, darker apically, pale basally.

Abdomen cordate, short black pubescent, but the pubescence entirely white on segments 1 and 2, and segments 2-5 with white apical fasciæ, these entire but rather narrow; segment 6 slightly concave at sides viewed from above, the apex rather evenly rounded; slightly concave in profile also, but so slightly as to be hardly noticeable, with no erect hairs visible in profile, finely and closely punctured, pubescence appressed, yellowish-white, more or less reddened medially to apex, hiding the surface on apical half, thin basally, with scattered inconspicuous erect black hairs at sides; scopa entirely yellow, but with a few lateral dark hairs on segment 6. Length 13 mm.

Type: Female (Type No. 15719, Mus. Comp. Zool.); Oak Creek Canyon, Arizona, 6000 ft. altitude, Aug. (F. R. Snow, collector). Paratype: 1 female, topotypical.

In *mendica* s. str. the pubescence of segment 2 is black on the disc, and that on segment 6 is entirely dark, while in this form the pubescence of segment 2 is pale, and segment 6 is covered over most of its surface with whitish appressed pubescence. Otherwise the two forms are very similar.

Megachile laurita n. sp.

♀. Head broad, eyes subparallel; supraclypeal plate closely and finely punctured, with some shining impunctate spaces medially; clypeus rather coarsely punctured, the punctures more separate medially, crowded above and at sides, apex thickened medially, the upper margin slightly but broadly produced medially; mandibles broad, reddish apically, coarsely striately punctate above, very closely and finely punctate on outer face at base, striately punctate medially, 3-dentate, the apical tooth bluntly rounded (apparently worn), the subapical tooth subacute, the cutting edge long, with an upper and an under carinate margin, but not much hollowed out between the two, the upper one broadly incurved, the under one more nearly straight; cheeks broad, closely punctured above, sparsely so below where the surface is finely tessellated; vertex slightly rounded, punctures mostly well separated, very fine and close between ocelli; lateral ocelli about equally distant from eyes and edge of vertex; front below ocelli densely punctured; antennæ dark above, reddish below, somewhat flattened, short, the middle joints fully as broad as long; pubescence fuscous on cheeks and vertex, some pale hairs intermixed on the vertex, and occiput largely fringed with pale hairs, pubescence of front and of inner orbits largely whitish with some black hairs intermixed, pubescence entirely black on clypeus and on orbits below.

Thorax with pubescence whitish above, at sides, and behind, fuscous on sternum and on pleura below; mesonotum with punctures well separated, almost sparse medially, close laterally and behind; scutellum closely punctured except for an indefinite median longitudinal impunctate line; pleura with punctures close and fine above, rather coarse and well separated below; propodeum with scattered, fine, indistinct punctures laterally, basal triangle finely granular; tegulæ somewhat bronze colored, varying in different reflections, closely punctate anteriorly and posteriorly,sparsely so medially; wings subhyaline, faintly dusky apically, nervures brownish, basal nervure beyond transverse median, second recurrent nervure entering second submarginal cell nearer apex than the first does to base; legs piceous, with fuscous pubescence, purplish ferruginous on tarsi beneath; apical projections of front and middle tibiæ piceous, of the same general color as the legs, quite prominent; spurs testaceous; claws testaceous basally, ferruginous to piceous apically, with no basal teeth.

Abdomen ovoid, shining, punctures very sparse and fine apically, closer basally, pubescence black, white on basal segment and slightly so at base of second; segments 1-5 narrowly white fasciate, the fasciæ somewhat thinner medially but conspicuous because of the otherwise black pubescence; segment 6 short and broad, shining, sparsely punctate, but very slightly concave at the sides when viewed from above, and straight in profile, pubescence entirely black and erect, subappressed apically; scopa entirely black. Length 11.5 mm.

Type: Female (Type No. 15711, Mus. Comp. Zool.); Umatilla, Oregon, June 24, 1882 (Samuel Henshaw, collector).

Megachile laurita semilaurita n. subsp.

♀. Very close to the preceeding species, and answers to the description except for the following differences:

Much larger (14 mm.); mandibles but slightly reddish above;

clypeus thickened apically, but hardly produced medially, the thickened edge grooved; cheeks sparsely punctate below and polished between the punctures, not tessellate, the pubescence mostly white, with short black pubescence around the posterior orbits; tegulæ rather closely punctate throughout; pubescence on outer faces of tibiæ pale; abdominal fasciæ broader, more dense and more conspicuous.

Type: Female (Type No. 15712, Mus. Comp. Zool.); Utah

Megachle laurita sublaurita n. subsp.

♀. Very close to the preceeding two forms from which it differs only in the following characters:

Smaller than *laurita* (10 mm.); clypeus with a broad, rather prominent median produced area on apical margin, which is shining and impunctate; lateral ocelli considerably nearer the edge of the vertex than to the nearest eye (distance subequal in the two preceeding forms); cheeks with pubescence largely white, black around posterior orbits, punctures on lower cheeks shallow, not widely separated, somewhat shining, but hardly tessellate; some black hairs in center of the mesonotum (apparently entirely white in the two preceeding forms, but *laurita* is somewhat rubbed); tegulæ rather sparsely punctured medially; pubescence of hind tibiæ more whitish, of the front and middle tibiæ rather ochraceous; fasciæ broad dense and conspicuous.

Type: Female (Type No. 15713, Mus. Comp. Zool.); Utah.

These three forms closely resemble *M. anogræ* Ckll. in form and structure but are totally different in color of pubescence, the entirely black scopa at once distinguishing them. They were at first taken to be the same species but the disparity in size made this seem somewhat doubtful, and there seems to be enough difference other than size to separate them at least into subspecies. The males would possibly show even greater differences. The study of additional material may show whether or not these should be separated as distinct species. The following key will serve to distinguish them:

1. Hair of cheeks entirely blackish. . . . .*laurita*
   Hair of cheeks white in part. . . . . .2.

2. Larger (14 mm.); apex of clypeus thickened and shallowly grooved. . . . . *semilaurita*
   Smaller (10 mm.); apex of clypeus with a broad median produced area which is shining and impunctate. *sublaurita*

Megachiloides umatillensis n. sp.

♂ Head broader than long, eyes somewhat converging below, densely covered with ochraceous pubescence in front, of the same general color but thinner above, short, thin and white on the cheeks, somewhat longer below; clypeus closely punctured, apex beneath beard entire; mandibles obscurely reddish apically, strongly 3-dentate, rather thickly covered with whitish-ochraceous pubescence, inferior tooth subbasal, slender, acute, the pointed apex curved slightly back; cheeks broad, only slightly narrowed above, very closely and uniformly punctate throughout, the lower angle with a very slight hollow and tooth, these largely obscured by the pubescence; vertex very slightly rounded, punctures close between ocelli and along the posterior margin, rather widely separated between eyes and ocelli; lateral ocelli about equally distant from eyes and edge of vertex; antennæ black above, piceous below, the middle joints hardly twice as long as wide, the terminal joint longer, somewhat flattened but not dilated; tongue extremely long, the second joint of the labial palpus almost three times as long as the first.

Thorax with entirely light pubescence, ochraceous above fading to whitish below; surface of mesonotum almost hidden by the pubescence, punctures fine and indistinct, the surface between the punctures coarsely tessellate or granulate; scutellum densely pubescent, punctures close and fine; pleura very closely punctate, with long dense pubescence; propodeum largely bare laterally, with long dense pubescence behind, punctures fine any indistinct; tegulæ piceous, densely pubescent anteriorly, closely and minutely punctate; wings subhyaline, faintly clouded apically, nervures testaceous, basal nervure beyond transverse median, second recurrent nervure entering the second submarginal cell very near the apex, the first rather distant from the base.

Legs with entirely pale pubescence, yellowish on middle and hind tarsi beneath; front coxæ dark, with stout spines, the apices of which are rounded and with a small patch of golden pubescence, a patch of reddish bristles at the base of the spines on the outer side; front femora somewhat keeled apically, posterior face very closely and finely punctured along the edge of the keel, densely pubescent, that and the upper face reddish-piceous, antero-inferior face polished testaceous; front tibiæ dark on outer face, testaceous apically, punctate and white pubescent, the other two faces reddish-testaceous, the ridge between them with some short dense pubescence and a long, thin, posteriorly directed fringe of white hair; front tarsi dilated but not widely so, ivory-yellow, dark along posterior border of the first three joints, this more noticeable beneath, the first joint hollowed out in front and both anterior margins fringed with short yellowish pubescence, the second and third joints less widely dilated, the fourth not at all, the fifth joint yellow basally, ferruginous apically, tarsal fringe fairly long, white exteriorly, dark brown beneath; middle and hind femora considerably swollen, the mid tarsi not much modified, but with a white posterior fringe and densely white pubescent without on the first joint; spurs reddish-testaceous, those on the front legs somewhat paler; claws reddish-testaceous basally, ferruginous apically, deeply cleft, without basal teeth.

Abdomen broad, gradually narrowed apically, pubescence entirely ochraceous except for some short black hairs on disc of segment 5, segments 1-5 with dense broad whitish apical fasciæ, that on segment 1 narrow and inconspicuous; punctures very fine and close on basal segment, more coarse and well separated on apical segments; segment 5 with a median longitudinal ridge at base; segment 6 very closely punctured above carina, broadly triangular, and somewhat downcurved in profile, very coarsely punctured beneath and with a ventral longitudinal furrow, around and in which the punctures are very fine and close, apical margin of the segment conspicuously carinate on either side of the middle, each carina narrowing to the lateral minute teeth, abrupt on the inner side; segment 7 quite conspicuous, very closely and finely punctured, somewhat excavated above, triangularly pointed apically; four ventral segments visible, these shining and sparsely punctate, the fourth with a broad membranous margin. Length 13 mm.

♀. Head broad, eyes subparallel, pubescence entirely ochraceous except for some short black hairs on the vertex, intermixed with long pale pubescence, that on the cheeks whitish; supraclypeal plate sparsely punctured medially, closely so laterally; clypeus with punctures rather sparse apically, closer and finer laterally and above, apical margin entire, smooth and impunctate; mandibles bright ferruginous apically, upper face rather coarsely striately punctate, outer face at base closely and finely punctate, polished and impunctate in region of the teeth, 4-dentate, the apical tooth very long and acute, the second tooth shorter but acute, the third minute, the upper margin of the mandible strongly and rather broadly incurved between the two inner teeth, the lower margin or cutting edge nearly straight; cheeks fairly broad, closely and finely punctate above and along the posterior orbits, more coarsely and sparsely punctate below, rather shining; vertex almost flat, the punctures close medially, well separated laterally, becoming close again on cheeks; lateral ocelli about equally distant from eyes and edge of vertex; antennæ piceous above, more reddish below, middle joints slightly longer than wide; tongue as in the male, the second joint of the labial palpus being fully three times the length of the first.

Thorax with pubescence entirely pale, ochraceous above fading to whitish below; mesonotum dull, tessellate, the punctures small, separated medially, close elsewhere; scutellum closely and finely punctured; pleura closely punctured, the punctures fine above, coarser below; propodeum rather bare and shining laterally, with long dense pubescence posteriorly where it has fine and rather close indistinct punctures, basal triangle granular; tegulæ ferruginous, closely and minutely punctate, densely pubescent anteriorly and rather thinly covered with short pubescence elsewhere; wings subhyaline, faintly clouded apically, nervures brownish-testaceous, basal nervure beyond transverse median, second recurrent nervure entering second submarginal cell almost at extreme apex, the first being rather distant from the base; legs piceous, pubescence whitish, reddish-brown on tarsi beneath, the middle and hind tarsi not greatly broadened, the middle tarsi densely whitish pubescent without; spurs reddish-testaceous; claws testaceous basally, ferruginous apically, without distinct basal teeth.

Abdomen broad, sides subparallel, rather suddenly narrowed apically, pubescence ochraceous except for some short inconspicuous black pubescence on discs of segments 4 and 5; segments 1-5 with entire, dense, whitish apical fasciæ, broad on apical segments, narrowed medially on the basal segments; punctures fine and close in general, well separated on discs of segments 4 and 5; segment 6 slightly concave at sides viewed from above, straight in profile, closely punctured, pubescence entirely light, largely subappressed, with scattered erect hairs basally; scopa white with a faint yellowish tinge, entirely black and short on segment 6. Length 13 mm.

Type: Male (Type No. 15714, Mus. Comp. Zool.); Camp Umatilla, W. T., Washington Territory June 26, 1882. Allotype; topotypical. Paratypes: 3 males, topotypical; 1 male, Little Spokane, W. T., July 26, 1882 (Samuel Henshaw, collector).

This interesting species is quite similar to the type species of the genus, *M. œnotheræ* Mitch., but is considerably larger and the pubescence is almost entirely ochraceous. In *œnotheræ* the pubescence is white, with a patch of black hair on the mesonotum and the length is 9-10 mm. *M. œnotheræ* ♀ was described as being 3-dentate, with a notch on the inner side of the second tooth. In *umatillensis* this notch is represented by a distinct though small tooth, and the apical tooth is much longer than in *œnotheræ*. In the male the front tarsi are more dilated and hollowed out in this species and are distinctly pale in color, whereas in *œnotheræ* they are but slightly dilated and hollowed out and are black in part.

NOTES ON THE NESTING HABITS OF SOME OF THE LESS COMMON NEW ENGLAND BUMBLEBEES.[1]

By O. E. Plath,
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In the fall of 1922, I published a short paper (1922b) on the nesting habits of several of our North American bumblebees. The data recorded were obtained from the study of about 50 nests, most of which were taken in the vicinity of Boston during the summers of 1921 and 1922. Since that time, this number has been increased to over 250 nests, of which more than 200 were examined. Several of these nests belonged to some of our less common New England species, about whose nesting habits—in most cases—comparatively little is known. Among the data presented in the following pages I have included some observations which Dr. Joseph Bequaert and Professor O. A. Stevens were kind enough to communicate to me. Unless otherwise stated, the nests referred to in this paper were taken within the city limits of Boston, either on, or near the grounds of the Arnold Arboretum, or the Bussey Institution.

Terrestris Group.

1. *Bremus terricola* Kirby.

Practically nothing was known concerning the nesting habits of this species before the appearance of my first paper (1922 b) which contained data concerning two nests, one taken in the Arnold Arboretum, and the other at Washington, Me. Since then I have been so fortunate as to discover 16 additional nests of this species. One of these was found near the skeleton of a dead rat in a nest which had been built—possibly by this same rat—among some old straw in a box left in the basement of an abandoned greenhouse. The other fifteen were subterranean, and of these, eleven were dug up. These were situated from 6 to

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 280.

18 inches below the surface of the ground, and had entrance tunnels ranging from about 6 inches to 3 ft. in length. Most of the colonies did not average over 50 individuals; four, however were considerably larger; one, taken on July 12, 1923, consisting of the old queen, about 50 young queens, and over 150 workers, besides a large number of cocoons. Interspersed with the latter were about a dozen pollen cylinders, similar to those frequently found in the nests of *Bremus affinis.* These cylinders contained more than a quarter of a pound of pollen.

In an earlier paper (1922a) attention was called to the fact that *Psithyrus laboriosus* is parasitic on *Bremus vagans,* while *Psithyrus ashtoni* is a parasite of *Bremus affinis.* In a letter, dated March 24, 1923, Professor O. A. Stevens, of North Dakota Agricultural College, makes the following comment on the above statement: "I have supposed that *Ps. laboriosus* must be parasitic on *B. vagans* here. Both species seem especially characteristic of the wooded area along the river. *Ps. ashtoni* is even more common, but *B. affinis* is rare, so some other host must be sought. I suspect *B. terricola,* but have no direct evidence as yet." As in the case of Dr. Frison's prediction in regard to the host of *Psithyrus laboriosus* (cf. 1922a, p. 29), I am pleased to be able to confirm Professor Stevens' surmise. On August 8, 1924, I took a nest of *Bremus terricola* which contained 3 workers, 3 young females of *Psithyrus ashtoni,* and several males and females of the latter species which had died in their cocoons before hatching. This is the only one of the fourteen nests of *Bremus terricola* in which young of *Psithyrus ashtoni* were reared, while 11 of the 36 *Bremus affinis* nests which have been examined were parasitized by this Psithyrus.

In the summer of 1922, I took two nests of *Bremus affinis,* one of which contained (1) the old queen, 1 young queen, and 43 workers of *Bremus affinis*; (2) 12 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola.* The other contained (1) 23 workers of *Bremus affinis*; (2) 9 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola.* The heterogeneous nature of these two colonies led me to surmise that *Bremus affinis* var. *novæ-angliæ* might be a hybrid between *Bremus affinis* and *Bremus terricola,* these two species being closely related. Since then, however, four more mixed colonies of these two species have been taken, two of which contained a much greater proportion of *terricola* workers than the two nests found in 1922. The first of these four mixed colonies was taken July 3, 1923. It consisted of the old queen and 6 workers of *Bremus affinis*, and 1 worker of *Bremus terricola*. The second was taken on August 9, of the same year, and contained the old queen and about 75 workers of *Bremus affinis*, and 1 worker of *Bremus terricola*. The remaining two were both discovered in 1926, one being taken July 5, and the other July 8. The first of these consisted of (1) the old queen and 29 workers of *Bremus affinis*, (2) 7 workers of *Bremus terricola*, and (3) a female of *Psithyrus ashtoni* and a considerable quantity of Psithyrus brood in various stages of development. The other consisted of 15 workers of *Bremus affinis*, 3 of *Bremus terricola*, and some brood of *Psithyrus ashtoni* which hatched later. No additional workers of *Bremus terricola* hatched from any of these six nests, the first four producing only young of *Bremus affinis* and, the last two nothing but *Psithyrus ashtoni*.

As was suggested recently in a joint paper with Dr. Bequaert (1925), the difference in coloration between the typical form of *Bremus affinis* and its variety *novæ-angliæ* is probably due to environment rather than hybridism. The presence of the workers of *Bremus terricola* in 6 of the 36 *affinis* nests is easily explained by "natural requeening," a subject which I discussed in a recent paper (1924), the only difference being that in this case, as with *Bremus lucorum* and *Bremus terrestris* in Europe (cf. Sladen 1912), requeening is accomplished by a closely related species.

To these data may be added some observations of Professor O. A. Stevens, who informs me that he found a populous nest of *Bremus terricola* under the floor of a shed, the bees entering by a hole in the roof.

PRATORUM GROUP.

I. *Bremus perplexus* Cresson.

What is known about the nesting habits of *Bremus perplexus* we owe to Franklin (1912-13) who took two nests in Vermont, early in August. Both were situated in the walls of houses, and were made of wool, one containing 5 queens, 1 male, and 9 workers, and the other 8 queens and 33 workers. I was fortunate enough to discover two nests of this rather rare New England species during the summer of 1925. One of these was taken on July 3, under a large root near the base of a tree, the nest being about a foot below the surface of the ground, with a tunnel 2 ft. long. In it were found 22 workers, 1 male, and some brood, from which additional males hatched later. The second nest was taken on July 23. It was situated 6 inches below the surface, and, like the first, had a tunnel about 2 ft. long. It contained 9 young queens, two of which had recently died, 1 dead male and 357 empty cocoons, showing that this must have been a prosperous colony earlier in the year.

II. *Bremus ternarius* Say.

Very little is known concerning the nesting habits of this species. In 1863 Putnam (1864) took a nest at Bridport, Vt., which was situated either under an old stump or under the clapboards of a house.

Early in September, 1923, Professor C. T. Brues called my attention to the fact that a nest of *Bremus ternarius* had been discovered on his summer estate near Petersham, Mass. Through the kindness of Professor and Mrs. Brues it was possible for me—after much digging—to secure the nest of this handsome but vicious species on September 15. The nest was situated among some trees near a red clover field, and was about 2 ft. below the surface of the ground, with a tunnel 6 ft. long. This colony consisted of 23 young queens, 16 males, over 100 workers, and a large quantity of brood, with more than 75 young queens still in their cocoons. The colony was transferred to the Bussey grounds where it prospered for over a month. Probably as a result of this transfer, *Bremus ternarius*, which is rarely found in the vicinity of Boston, was fairly common in the Arnold Arboretum in 1924 and 1925 from early April to October.

FRATERNUS GROUP.

I. *Bremus separatus* Cresson.

The only thing known concerning the nesting habits of this species is Putnam's (1864) statement that *Bremus separatus* builds its nests "under old stumps and in other situations similar to those in which the nests of *B. fervidus* are found."

I discovered two nests of this species on the surface of a grassy bank on Moss Hill, adjoining the Arnold Arboretum. One of these was found on July 26, 1923, after having been destroyed, probably by a skunk. Among the scattered debris were found three living workers, and the dead bodies of the old queen, two young queens and a fourth worker. The marauder had also left behind over 90 empty cocoons, to which were attached two egg cells, containing 2 and 5 eggs respectively.

The second nest was taken on June 23, 1924. It contained the queen, ten cocoons, a considerable number of larvæ and eggs, and two honey-pots with a common wall (cf. fig. 1). Two other peculiarities of the double honey pot found in this nest were, (1) that its walls were about twice as thick as those of the single pot (cf. fig. 2) usually found in incipient nests of *Bremus impatiens* and *Bremus vagans*; and (2) that it was completely closed at the time the nest was taken, whereas the other two species mentioned apparently never close their honey-pot.[2] The nest was transferred to one of the windows of the Bussey Dormitory, where other observations were made on this rare species during the remainder of the summer.

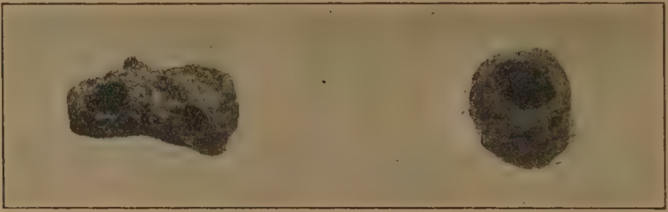

Fig. 1. Double honey-pot of *Bremus separatus* Cresson.
Fig. 2. Single honey-pot of *Bremus impatiens* Cresson.

Dr. Joseph Bequaert has been kind enough to furnish me with data concerning a nest of this species which he took on July 12, 1918, at Orient, Long Island. The nest was situated in a log on the seashore and, in addition to the comb, contained the old queen and about a dozen workers.

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[2] Since writing the above, I have discovered the following note by the late F. W. L. Sladen (cf. Root, 1923, p. 172): "The queen's honey-pot in a nest of *B. fervidus* examined at Ottawa, Canada in 1915, was found to be completely closed, possibly a protection of nature, preventing ants, etc., from discovering the honey when the queen is absent from the nest."

DUMOUCHELI GROUP.

I. *Bremus americanorum* Fabricius.[3]

Bremus americanorum is one of the most common bumblebees in the central and southern plains of the Middle West, and hence we probably know more about its nesting habits than those of any other of our North American species, chiefly through the work of Franklin (1912-13), Howard (1918), Frison (1916, 1917, 1918, 1921), and Rau (1922, 1924). However, since *Bremus americanorum* is rare, if not completely absent, in a large part of New England, it seems desirable to record the taking of a nest of this species in the Arnold Arboretum on July 30, 1923.

The nest was discovered in an open field and was about 6 inches below the surface of the ground with a tunnel more than a foot long. In it were found, the old queen, 37 workers, and a considerable quantity of brood. The queen of this colony had only one antenna, but this apparently did not interfere greatly with her duties, since she was seen to oviposit on several occasions during the month of August.

According to Frison (1917, 1918), Ranslow (cf. Howard, 1918), and Rau (1924), *Bremus americanorum* is rather vicious, a fact which was painfully impressed upon several of my friends shortly after the colony was transferred to the grounds of the Bussey Institution. In fact it was necessary to remove it to another place, since the workers attacked anyone venturing within twenty-five feet of the nest.

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[3] Dr. Joseph Bequaert and the writer have recently studied De Geer's description and figure of *Bremus pennsylvanicus*, and, like Frison (23), have come to the conclusion that it is better to use the name *americanorum* until the type specimen of De Geer is located.

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THE REACTION OF DATANA LARVÆ TO SOUNDS.

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A considerable amount of discussion has been devoted to the possibility of the presence of an auditory sense in insects. Unfortunately, much of this discussion has been purely theoretical. At one time it was generally supposed that all or most insects could hear. This argument was based upon two facts: the possession, by insects, of sensory organs which have a structure indicating a possible auditory function, and the insect production of sounds. For what other purpose, it was argued, can stridulating organs be used, if not for that of impressing other insects?

Fabre fired two mortars in close proximity to a number of Cicadæ without affecting their songs. He concludes, "If any one were to tell me that the Cicadæ strum on their noisy instruments without giving a thought to the sound produced and for the sheer pleasure of feeling themselves alive, just as we rub our hands in a moment of satisfaction, I should not be greatly shocked." Lutz (1926) is of the same opinion. He writes: "When we can explain the purpose of a man's snoring or the rattling of a Ford car, we may know why this beetle grub rasps. Having slept with a man that snored and having driven a Ford, I believe that the sounds in question are unintentional and quite incidental to the structure of the man and of the machine. May not the same be true of the beetle grub?"

In spite of such incomplete considerations of the subject, there is evidence that certain insects have an auditary sense.

Radl (1905), arguing in part from structure, and in part from experiment, concludes that insects have auditory powers of a primitive and limited kind.

In 1914 Turner and Shwarz tested the auditory powers of various Catacola moths, and found that from 80 to 100 percent of the insects gave positive responses to notes of the pitches C,4 A,4 and B4 from a Galton whistle. In the same year Turner conducted a number of similar experiments, using the adults of the large Saturnidæ as subjects. A majority of the insects gave positive responses to a wide range of notes sounded on various wind instruments.

In 1925, Kroning tested the auditory sense of bees with a siren. His extensive experiments lead him to the conclusion that, "die Bienen konnten keine Tone wahrend des Fliegens horen, wohl aber in Marsch oder wahrend des Sitzens."

Minnich (1925) brings forth positive evidence in support of the presence of an auditory sense in the larvæ of Vanessa antiopa. His experiments were extensive and complete. He found that these larvæ, when stimulated by sounds, quickly elevated the anterior third of the body. Minnich was very careful to eliminate other possible sources of stimulation. The larvæ of all instars responded; even headless individuals, and parts of the body were capable of response. Minnich also removed the spines; in other cases he loaded them with water droplets or dry flour. Larvæ so treated failed to respond to sounds. The larvæ were tested with a wide range of notes. Mature larvæ responded to notes between C " (1024 vibrations) and C3 (32 vibrations.)

Original Experiments

The experiments of Minnich suggested to me the possibility of similar reactions in Datana larvæ. These insects are the caterpillars of certain moths. They feed in groups, and give very definite responses to various external stimuli. Air currents, sudden jars, and certain sounds cause each larva to elevate the anterior and posterior thirds of its body; contact with the substratum is maintained by means of the four middle pairs of prolegs. If the stimuli are continued, the insects may throw their heads from side to side.

The larvæ of *D. perspicua* feed on sumac. Just prior to metamorphosis they measure about two inches in length by one-fourth of an inch in width. Their general color is black, but they are marked by several longitudinal yellow stripes. The body is covered with long grayish hairs, so sparsely that the surface of the body is easily visible, but plentiful enough to constitute a marked anatomical feature. The larvæ of *D. ministra* feed on various species of Cratægus. They resemble the larvæ of *D. perspicua* very closely; the most striking difference is due to the orange color of the prothoracic segment. The responses of the two species are similar, but those of *D. ministra* are not as marked as those of D. perspicua.

Preliminary tests demonstrated that these larvæ give marked responses to only two notes: middle C (512 vibrations) and F sharp above middle C (728 vibrations). The responses were very distinct. The instrument used in making the tests was a closed pipe with a movable plunger. Eleven larvæ were used in each test. The number was purely arbitrary. They were taken from a large cage in which they were kept, and placed on a vertical stick. The tests were made after the caterpillars started to creep. In every case, efforts were made to protect the insects from air blasts from the pipe.

In the critical series of tests, normal larvæ of *D. perspicua* were used only as controls, but a complete set of tests was made with normal larvæ of *D. ministra.*

Attention was chiefly directed toward the rôle of the hairs in the detection of sounds. The methods employed were similar to those used by Minnich in 1925; the hairs were "loaded" with water or shellac. The liquids were sprayed on to the hairs with a nasal "atomizer." As the water had a tendency to run off, it had to be frequently renewed. The shellac was the commercial orange product diluted with an equal volume of ethyl alcohol. Its value lay in its stability; the alcohol soon evaporated, leaving the droplets of shellac fixed on the hairs. These methods of treatment did not seriously injure nor inconvenience the larvæ. Some specimens of *D. perspicua* were bathed with a 2 percent solution of procain. Although this inhibited responses, it was more or less injurious, and several of the insects so treated subsequently died.

Ten trials were made with each group of larvæ; five for each set of vibrations. Four specimens of *D. perspicua* were tested after removing the hairs from their bodies by clipping. Normal insects were also tested with a piano and a mandolin. The results of the experiments are tabulated as follows:

Table I *Datana perspicua*

Vibration	Water	Shellac	Procain
512	—	—	—
728	slight	—	slight
512	—	—	—
728	—	—	—
512	—	—	—
728	—	—	—
512	—	—	—
728	—	—	—
512	—	—	—
728	—	slight	—
Control	+	+	+

Table II *Datana ministra.*

Vibration	Normal	Water	Shellac
512	+	—	—
728	+	—	—
512	+	—	—
728	+	—	—
512	+	—	—
728	+	—	—
512	+	—	—
728	+	—	—
512	+	—	—
728	+	—	—

Discussion.

The results of these experiments are startling. In only three were even slight responses elicited after treatment. That the responses are actually due to the sound is evident from the following facts: the response of normal larvæ is given when the insects are protected from all air currents, it can be elicited when the larvæ are several feet away from the source of the sound, it was given to any one of three different musical instruments, and finally it was elicited when all possibility of vibrations of the substratum were eliminated.

These facts are supported by the results obtained when the hairs were loaded or removed, or when the body surface was anæsthitized.

What is the significance of this peculiar sense? The larvæ give marked responses to only two notes, which, even if they were frequent under natural conditions (which they certainly are not), could hardly be considered of importance to the caterpillars. They are, therefore, not adaptive. It is probable that we are here in the presence of a "secondary" sense, developed as a result of the adaptation of certain organs to more significant stimuli.

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ANOTHER VAGRANT GRASSHOPPER.

By Albert P. Morse,
Peabody Museum, Salem, Mass.

On December 17, 1926, a curious green, wingless, grasshopper-like creature was brought to me alive from Tassinari's fruit store, Salem, the same place where other wanderers have been found (see Psyche, April, 1926, p. 53). This one proved to be Davis' Short-winged Conehead, *Belocephalus davisi* S. D. H. ♀ undoubtedly brought in with garden truck from Florida.

The European House-Cricket, *Gryllus domesticus* L., has been found in considerable numbers in a schoolhouse at Salem this winter, making its presence known by its loud and persistent singing in the basement.

THE BOWDITCH COLLECTION OF CHRYSOMELIDÆ.

The Museum of Comparative Zoology has receivied from the family of the late Mr. F. C. Bowditch his very extensive collection of Coleoptera. The main part is an arranged collection of the Chrysomelidæ of the world in double boxes equal to more than five hundred Schmitt boxes. This contains between 2500 and 3000 types, mostly of Martin Jacoby. Mr. Bowditch had purchased Mr. Jacoby's first collection (including a set of the Biologia), part of the second Jacoby collection, the 70,000 specimens of the Tring Museum (containing some Jacoby types) and several smaller collections. In recent years he had bought from dealers and collectors in all parts of the world. There is about an equal amount of duplicate Chrysomelidæ, partly named, and containing the Hispinæ and the Cassidinæ which are not included in the general collection. There is also a large collection of North and South American Coleoptera based on the famous G. D. Smith collection. The material is all in excellent condition. During his life Mr. Bowditch presented to the Museum tens of thousands of duplicate Chrysomelidæ, partly named, the whole doubtless making the greatest mass of material in this family ever accumulated anywhere.

N. Banks.

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